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HEARING

ON

NATIONAL DEFENSE AUTHORIZATION ACT FOR FISCAL YEAR 2017

AND

OVERSIGHT OF PREVIOUSLY AUTHORIZED PROGRAMS

BEFORE THE

COMMITTEE ON ARMED SERVICES
HOUSE OF REPRESENTATIVES
ONE HUNDRED FOURTEENTH CONGRESS

SECOND SESSION

SUBCOMMITTEE ON STRATEGIC FORCES HEARING

ON

FISCAL YEAR 2017 BUDGET REQUEST FOR NATIONAL SECURITY SPACE

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FISCAL YEAR 2017 BUDGET REQUEST FOR NATIONAL SECURITY SPACE

HOUSE OF REPRESENTATIVES,
COMMITTEE ON ARMED SERVICES,
SUBCOMMITTEE ON STRATEGIC FORCES,
Washington, DC, Tuesday, March 15, 2016.

The subcommittee met, pursuant to call, at 3:05 p.m., in room 2118, Rayburn House Office Building, Hon. Mike Rogers (chairman of the subcommittee) presiding.

Mr. ROGERS. All right. This hearing of the House Armed Services Subcommittee on Strategic Forces will come to order.

I want to thank all of our witnesses for being here and taking the time to prepare for this hearing.

We are going to have a problem with votes in a little while, crunching our time. We have a big panel, so the ranking member and I have agreed that we are going to dispense with opening statements, both on our side and on your side, so we can go straight to questions and answers and try to get both the open side of this hearing as well as the classified part of this hearing done before they call us for votes, which we think will be around, what, 4:00? 3:30 or 4:00. I have no control over that.

So anyway, we will accept the opening statements for the record and go straight to questions, and I will recognize myself for the first set of questions. That is without objection. All right.

[The prepared statements can be found in the Appendix beginning on page 27.]

Mr. ROGERS. General Hyten, some have suggested that we should—well, first let me for the record acknowledge who all we have for witnesses here today.

We have General John Hyten, Commander, Air Force Space Command; Mr. Doug Loverro, Deputy Assistant Secretary of Defense for Space Policy; Dyke Weatherington, Acting Deputy Assistant Secretary of Defense for Space, Strategic and Intelligence Systems. I would like to see your business card. That is a lot to put on there.

Lieutenant General David Buck, Commander Joint Functional Component Command for Space; and Mr. Robert Cardillo, Director of National Geospatial-Intelligence Agency; as well as Frank Calvelli, Director of the National Reconnaissance Office, deputy director. It says director here. I was trying to give you a promotion.

Mr. CALVELLI. Thank you, sir.

Mr. ROGERS. Betty wouldn't like that, would she?

Mr. CALVELLI. No, she wouldn't.

Mr. ROGERS. Thank you all for being here. All right. We will go to questioning.

General Hyten, some have suggested that we should phase out Atlas V and go to Delta IV and Falcon 9 mix prior to a new U.S. engine being built. In testimony at the SASC [Senate Armed Services Committee] earlier this month, the Secretary of the Air Force stated that preliminary analysis showed it was going to cost $1.5 to $5 billion in additional costs, depending on assumptions of when to transition.

Can you provide your perspective on going to Delta-Falcon-only capability before we replace the RD–180? If this cost had to be taken out of existing space accounts, what would be the impact on the Air Force space mission?

General HYTEN. Thank you, Congressman. The impact on the existing Air Force space mission would be significant, because if you have to take billions of dollars out and try to do something else with it, what are you going to take out? Are we going to stop doing GPS [Global Positioning System]? Are we going to stop doing missile warning? Are we going to stop doing satellite communications? Those are very, very difficult questions. So it will actually come back to the Air Force and we will have to decide where to do that.

The number $1.5 to $5 billion is a significant number. What it should really tell you is, that in reality, we don't know how much that will cost us. The reason we don't know how much it will cost us, and the estimates are so huge is because, as the Secretary said, we have so many assumptions about what the future is going to look like. Are we going to have a Falcon 9 Heavy in the interim period between 2019 and 2022? What is the industry going to look like between 2019 and 2022? All those questions we really don't know the answer to.

We know if we come off of Atlas and go to Delta, there are certain things we have to do. SBIRS and AEHF, two of our big satellites today, the Space-Based Infrared System, the Advanced Extremely High Frequency satellite system, only fly on Atlas today, so we would have to figure out on how to move those to Delta. We would have to do the engineering analysis and maybe reconfigure those satellites and reconfigure the interfaces to do that, which means we will have to store AEHF and SBIRS for a certain period of time. All that costs us money. That costs us money in the near years.

Then Delta will be more expensive. There is no doubt Delta will be more expensive. The number is going to be in the billions, there is no doubt about that, but exactly where it comes out, I don't know. So planning for uncertainty is not a good place to be. So we would like to plan for certainty in the transition, which is why we are asking for additional RD–180s to allow us to compete.

Goodness knows we want off the Russian engine as fast as any human being on the planet. We want off the Russian engine as fast as possible. But, asking the American taxpayers to write a check for multiple billions of dollars in the future for an unknown is a very difficult thing to do, and for the Air Force, that will be a very difficult budget issue to work.

Mr. ROGERS. And I would like for the record to ask you this question. We have had testimony on panels that you have sat on, as well as a host of other people at this table, as well as others, who have said that they believe with some degree of confidence that we

can have a replacement engine and have it certified in the 2020 to 2022, 2023 timeframe. Is that something you still believe is accurate?

General HYTEN. So the two contracts we have just signed, for the first stage engine, both require delivery of that engine by December of 2019. It will then take 2 to 3 years to certify that into a rocket system to allow us to launch. So that means by 2022 to 2023, we should be ready to launch.

Mr. ROGERS. And you have confidence in that timeframe?

General HYTEN. I have more confidence today than I did last year. There is always risk in any development program that is looking at new technology. So there is risk in that, but I am more confident this year with both the Aerojet Rocketdyne solution, as well as the Blue Origin solution than I was last year, because the progress that we have made working with industry and the progress that I have seen from those two companies.

Mr. ROGERS. And my point in raising that is that this is not an infinite amount of time that we are talking about, that we have got to wrestle with this RD–180 issue, that we can see the light at the end of the tunnel if we just remain steadfast and find a way to make this—navigate these waters, and then get off of it permanently.

Mr. Calvelli, you heard General Hyten's observations about the Delta-Falcon mix. Do you agree with those, and can you tell us what impact that would have on NRO [National Reconnaissance Office] operations?

Mr. CALVELLI. Yes. I agree with what General Hyten answered, and as well as, you know, the implications to us are the same that the Air Force has, and I think one of the big things here would be the timing. So, for example, I have got unique vehicles that were designed around flying on an Atlas. If I was told, like, tomorrow they could not go on an Atlas, I mean, the cost would be higher. If it is a gradual transition over a period of years, the cost would be lower. And so it all depends on the timeframe of the decision is made.

Mr. ROGERS. But you would agree—I am asking. I don't want to ask leading questions——

Mr. CALVELLI. Okay.

Mr. ROGERS [continuing]. We are not in the courtroom, but would you agree that the timeframe after you get past 3 to 5 years is just hard to predict. I mean, there is no way to know that you are going to have, what kind of launch opportunities are going to be out there or demands.

Mr. CALVELLI. Sure. That is correct, sir.

Mr. ROGERS. All right. The underpinning of the Air Force RD–180 replacement plan is based on creating two commercially viable launch systems which all meet the EELV [Evolved Expendable Launch Vehicle] requirements. Let me give you two examples of what I have heard about the commercial market from experts on this point that we were just talking about. General Mitchell's study on the RD–180 reliance mitigation stated, quote, "Launch capability exceeds demand three to one to service this fixed market," closed quote. And you can see the monitors for a slide on this commercial launch environment according to General Mitchell's report.

[The slide referred to can be found in the Appendix on page 107.]

Mr. ROGERS. Separately, Ms. Katrina McFarland, who leads acquisition in OSD–AT&L [Office of the Secretary of Defense for Acquisition, Technology, and Logistics], stated in one of our launch hearings last year that, quote, "The 2014 commercial space transportation forecast that came out has a flat line on what we can anticipate in the future that would bring in, in terms of commercial NGO [non-governmental organization] to the government. They are all competing for the same size pie," close quote.

General Hyten and Mr. Weatherington, do you disagree with General Mitchell and Ms. McFarland's assessment of the commercial launch market? General Hyten first.

General HYTEN. So if you look at that chart, the one thing that should be clear to everybody is that we have never predicted the commercial launch market correctly. I don't think we fully understand what the commercial launch market is going to be, and I wouldn't bet exactly where the commercial launch market is going to end up in 3 to 5 years again.

What I would say is the commercial launch market is more mature. And the one thing, if you look at those numbers on there, there are still significant numbers available for the commercial launch industry. Our launch industry, unfortunately, has not been able to ever compete for those, because we have been way too high priced. If you look at how many EELVs, how many of the rockets, Atlas and Delta, that we have launched since the beginning, 92. Of those 92, 62 were for the Department of Defense [DOD] and the national security missions. Sixteen were for NASA, and 14 were for the commercial sector, only 14.

Mr. ROGERS. That is amazing.

General HYTEN. Fourteen in the entire history of the program. So whatever we do, we need to be more competitive and more commercially viable as we get to the out years. But that is why it is a public/private partnership, because the commercial sector is not there right now. We believe that, eventually, there will be a commercial industry in space, but even with the commercial industry we have right now, we need to be more competitive in——

Mr. ROGERS. What do you base that on when you say you believe there will be more of a commercial demand?

General HYTEN. Because I watch the maturation, especially in the satellite communication business, of how the satellite communication business has flourished in recent years. When we started these programs back in the mid-1990s, there was really no commercial business. There is a commercial business now. A lot of that commercial business goes overseas to launch. There is also a new business taking place, mostly out of Silicon Valley, that many people call "new space" that is looking at distributed constellations of numbers of small satellites. One of those companies is going to figure that out, because there is a huge business case for them to figure it out. When that happens, I can't tell you, I am not a business person. But I can tell you that that is much different than it was in the 1990s when we started down this path.

Mr. ROGERS. All right. Mr. Weatherington, you heard me try to recite Ms. McFarland and General Mitchell's observations. What are your thoughts?

Mr. WEATHERINGTON. Thank you, Mr. Chairman. So to leverage on what General Hyten said, from AT&L's perspective, the launch market really has three components. It has got the NSS [national security space] component; it has got the other U.S. Government component, largely NASA [National Aeronautics and Space Administration]; and it has got the commercial components. And as General Hyten indicated, all three of these components are difficult to predict in the future. Let me just give you one example. So for national security space, our manifest is flat to trending slightly downward through the FYDP [Future Years Defense Plan]. Later on, you will probably ask us some questions on resiliency, and General Hyten and his staff are working hard to develop strategies that address our lack of resiliency today.

One of those potential solutions is to disaggregate some constellations that likely would result in an increase in NSS launch capacity, but we aren't there yet. So it is difficult to predict what the NSS launch manifest will be in the future.

Other government contractors, NASA, we have got the question of where the International Space Station is going to go in the future, so that is an unknown. And, again, as General Hyten said, there is really two components for commercial: there is the base of commercial, commercial SATCOM [satellite communications], supporting a variety of users; and then this new space market that may be emerging.

Now, you know, we bought this before about 10 years ago where we anticipated the significant increase in commercial space, and that did not materialize. So I think the point here is we have to plan for various contingencies. From AT&L's perspective, we think the best solution moving forward is a plan that gives us two certified launch providers that support the entire NSS manifest, and some fraction of their capability could be used for the commercial or other government market. If that does not transpire, we still need two certified launch providers to provide the U.S. Government assured access to space.

Mr. ROGERS. Thank you. The Chair now yields to the ranking member from Tennessee, Mr. Cooper.

Mr. COOPER. I thank the chairman. I would also like to welcome the witnesses. It is a very distinguished panel. I will be saving most of my questions for the classified session later, but I would first like to associate myself with General Hyten's answer to the chairman regarding the RD–180. I thought that was very well expressed.

It worries me greatly the GPS OCX [Next Generation Operational Control System] ground system delays and cost overruns. And I noted that Lieutenant General Sam Greaves said that, quote, "It is the number one troubled program within the Department of Defense," end of quote.

Sadly there is a lot of competition for that title, but to be the winner is not something to be proud of. So if any of you would like to comment on that situation, I would love to hear your answer.

General HYTEN. Thank you, sir. I will start. I have been on the record expressing my displeasure of the OCX program. I called it a disaster in the press. And I think any program that is a billion dollars over budget and 5 years late meets the definition of a dis-

aster. But the question we have to ask ourselves is what is the best way forward, what is the best way out of this.

And Mr. Kendall and AT&L, and I will let Mr. Weatherington talk about the details, had a session in December, and a session just last week with the contractor, going through the details looking at the various options. And as we sit here today, the best answer is for Raytheon, the contractor involved, to deliver that capability in a time certain manner and give us the capability that we need to make sure that GPS is available for future years in a cyber secure environment.

And I will let Mr. Weatherington answer the acquisition details.

Mr. WEATHERINGTON. Sir, again, to leverage on General Hyten's comments, Secretary Kendall signed out an ADM [Acquisition Decision Memorandum] on 22 December that provided an additional 24 months of schedule for the program. It also set a requirement for quarterly deep dives. As General Hyten indicated, that first deep dive took place last week out at Aurora, Colorado. That was attended by Mr. Kendall and the Secretary of the Air Force, so I think that indicates this problem has significant senior leadership attention in the Department.

Currently, we believe there is reasonable expectation that Raytheon can deliver the capability that we need, but Mr. Kendall also directed the Air Force to develop off-ramps for the program in the situation that we can't close on this program.

I think it is also important to point out that while the program is troubled, the capability that OCX delivers is absolutely critical to the warfighter. We have got to improve our resiliency both in space and in ground, and that was one of the significant goals that OCX had. So whatever we do for the program specifically, we have to deliver that capability to the warfighter.

Mr. COOPER. Thank you. I have no more questions, Mr. Chairman.

Mr. ROGERS. I thank the ranking member. The Chair now recognizes the vice chairman of the committee, Mr. Lamborn of Colorado, for 5 minutes.

Mr. LAMBORN. I thank you, Mr. Chairman. And this will be both for General Hyten and General Buck, but there is a difference between JICSpOC [Joint Interagency Combined Space Operations Center] and JSpOC [Joint Space Operations Center]. Can you explain why each one is—where it is at and what are the plans going forward, especially for JICSpOC, which is the newer of those two organizations?

General HYTEN. Yes, sir. For the record, the Joint Space Operations Center is at Vandenberg Air Force Base, California. It is the day-to-day operation center that is commanded by General Dave Buck, the commander of the joint force component under Strategic Command, to lead the day-to-day operations.

And they have two fundamental missions that drive their focus: number one, they have to be organized, trained, and equipped to provide space support to theater warfighters around the world, and that is what they do tremendously well every day. And the second piece is they have to provide us situational awareness of everything that is going on in space. They end up providing that situational

awareness for us and for users around the world, including international partners as well as commercial partners.

What we realized is that if conflict does, God forbid, extend into space someday, we need to have the capability to focus on planning for that conflict. And so we decided that we would create an experimental organization at Schriever Air Force Base in Colorado, to look at experimentation of that conflict should it one day occur. We started that on the 1st of October and we continue to do that.

The reason that Schriever Air Force Base was chosen was really for a very simple reason, is that Schriever Air Force Base has unique connectivity. We can talk about that connectivity in detail in the classified session, but basically the bottom line is it is connected to every national security ground station in the world from Schriever Air Force Base. That connectivity is essentially important so that you can respond real-time to concerns and contingencies that may arise in space someday.

And so that is the basic reason why the JICSpOC, the Joint Interagency Combined Space Operations Center, was put at Schriever Air Force Base.

Mr. LAMBORN. Okay. Yeah, General.

General BUCK. Yeah. General, thank you, sir. I have nothing more to add. I think it was a very succinct answer and spot on.

Mr. LAMBORN. All right. Great. And then what is next for JICSpOC after the fourth and last experimental period in May?

General HYTEN. So after the fourth experimental period in the JICSpOC—well, actually we are going through that process right now. We have learned a great deal from the first three periods. We are continuing to look. We have proposals up to the senior leadership in the Department now about how we transition to a future construct.

You will see in our 2017 President's budget that we have requested money, a small amount of money, for the JICSpOC, as well as continuing funding for the JSpOC and the JSpOC mission system. We believe that both of those will have a significant role in the future, but that role will be determined by the senior leadership in the Department as we come to the end, but those recommendations are coming forward now.

Mr. LAMBORN. Well, I am just really excited about the potential for the Department of Defense and the Intelligence Community [IC] working together in an organized, formal way for the first time ever when it comes to space.

General HYTEN. Well thank you, Congressman, for that statement, because to me that is the number one lesson learned from the JICSpOC right now, is that the critical partnership we have with the NRO and the Intelligence Community, it is better than I have ever seen it in my 35-year career. It is remarkable the progress that we are making, and that partnership is critical to the future.

Mr. LAMBORN. Would anyone from the Intelligence Community like to add anything?

Mr. CALVELLI. Yes. So as you know—and I couldn't echo better the words General Hyten said, but as you know, I mean, there are adversaries out there that are trying to deny our capabilities that we have in space and the decisive advantage that space gives us.

The JICSpOC is an amazing effort between the IC and the DOD to share information, whether that is indications and warning, or whether it is on defensive kinds of maneuvers that we potentially could do, through a whole unity of effort between the two organizations.

And to me from an IC perspective, the more information we have between ourselves to share information and protect our systems, the better off we will be. So it is a great opportunity, and it is a great teamwork between the IC and DOD.

Mr. CARDILLO. I would just quickly echo those comments on both ends. It is a synergy we haven't seen before. NGA [National Geospatial-Intelligence Agency] is fully participating in all of these experiments so that we can best serve the Nation.

Mr. LAMBORN. Thank you. And one last question. General Hyten, you are asking for $20 million for a ground enterprise to take 17 different interfaces for ground control systems and make one system, so training is much more consistent throughout the Air Force. Do you want to respond to that?

General HYTEN. So it is taking 17 different ground systems that we have right now, and not creating a single ground system, but creating a single interface and a single common structure, because today we have to train our airmen, top rate, 17 different systems. That is inefficient, it is expensive, and it is also hard on our airmen.

So we would like to have a common interface, a common structure that everything plugs into so that the ground systems of the future will all be built to plug into that same common interface as we walk into that. That is what we are really talking about, the enterprise ground. That is why it is a fairly small amount of money, because it is really engineering work, system engineering analysis that has to be done to define where we are going to go in the future.

Because the money for the ground systems is actually in all these big programs, SBIRS, AEHF, GPS, they all have significant funding for the ground. The question is, how do we actually build that ground structure in the future so it is a common structure for our airmen to operate on.

Mr. LAMBORN. Thank you very much.

General HYTEN. Thank you, sir.

Mr. ROGERS. The Chair now recognizes the gentleman from Nebraska, Mr. Ashford, for 5 minutes.

Mr. ASHFORD. Thank you, Mr. Chairman. I just have a brief question, if I might. I was out at STRATCOM [U.S. Strategic Command] last week and met with General Wilson, and he gave a great brief on all the issues they are dealing with. Could someone answer, I do—one of the areas we talked about, of course, and we talk about a lot in here is cyber and being able to stand up the force necessary by 2018 to address those issues. Could someone just give a comment, General, on where that is? General Hyten.

General HYTEN. So I actually think I am the only one on the panel that can, so I apologize to my panel members, but I have cyber underneath my command as well. And so part of our job in the Air Force is to man our section of the Cyber Mission Force, 39

teams that we have to field. We are in the process of building those out right now.

The Cyber Mission Force is a key element. It consists of national mission teams to protect the Nation, combat mission teams to support the combatant commanders, and cyber protection teams to defend our own capabilities.

We are making progress. We are a little behind in the Air Force in stepping up to that. We have a training pipeline that is limited in how many people we can put through that. I know that commanders for Strategic Command and the commander of Cyber Command have both complained to my leadership about us going faster. We are doing everything we can to put extra capabilities, and figure out smarter ways to train our cyber professionals to get there.

Mr. ASHFORD. Thanks, General. Could I ask one follow-up? Do you see a benefit, we had some discussions about, to ramp up the training, to provide additional training sites, additional training opportunities? Is that something you are thinking about doing?

General HYTEN. It is. In fact, the Air National Guard is standing up a new unit in Arkansas——

Mr. ASHFORD. Right.

General HYTEN [continuing]. And one of the things we are looking at is how to better leverage the Guard as a total force to provide us additional training opportunities.

Mr. ASHFORD. And I think Nebraska is one of those National Guard teams as well.

General HYTEN. Yes. And the Guard is a perfect partner in cyber, more than maybe any other mission, because it can be done from anywhere, it requires unique training, it doesn't require 24/7, because you can come in and come out. It is a perfect total force mission, and we are looking at new ways to leverage the Guard and the Reserve to do that.

Mr. ASHFORD. Thanks, General.

Thank you, Mr. Chairman.

Mr. ROGERS. I thank the gentleman. The Chair now recognizes Chairman Forbes for 5 minutes for any questions he may have.

Mr. FORBES. Thank you, Mr. Chairman. Gentlemen, thank you for being here today.

Earlier this month in a House Appropriations hearing with Secretary James and General Welsh, they were asked a question about eliminating single-point failures in space launch by continuing development of secondary launch sites at Wallops Island, Virginia, and Kodiak, Alaska, which help support small- and medium-class launches for DOD, civil, and commercial users. In response, General Welsh stated that, quote, "As we look at the space enterprise and how we do it differently in the future as we look at more disaggregation, micro sats [satellites], cube sats, small sats, things that don't have to go from a large launch complex, I think proliferating launch complexes is going to be a natural outshoot of this."

He added, "this is the kind of thing General Hyten is talking about. How do we change the game for the long-term."

General Hyten, as you know, Wallops and Kodiak represent the only other launch sites in the United States capable of launching to orbit outside of the Cape and Vandenberg. Could you please

elaborate on General Welsh's comments about opportunities to make greater use of these space ports to support DOD missions?

General HYTEN. So the most important element in General Welsh's statement was the existence of smaller satellites and different satellite architectures in the future. We believe, and we have built something we call the Space Enterprise Vision, the joint vision with the National Reconnaissance Office, where we look at different ways of doing business in the future. And smaller satellites—not necessarily small, but smaller satellites are a key piece of that puzzle.

One of the reasons that we only operate out of the Cape and Vandenberg today, Cape Canaveral in Florida and Vandenberg in California, is because the satellite processing facilities that are required in order to move those satellites onto the rockets only exist at the Cape and Vandenberg. We could not do that out of Kodiak or Wallops today.

But as we move into a different structure where we have smaller satellites, and small satellites, and maybe cube sats as well as someday to do missions, we will need to take advantage of it. That also builds resiliency into our launch infrastructure. We have vulnerabilities when everybody knows that the only place that we launch our rockets from are at Cape Canaveral and Vandenberg. It is better to have more places to launch from.

I will be going up to Alaska in 2 months to visit Kodiak. I look forward to that. I have seen Wallops in the past. I did Wallops missions way, way back when, when I was a captain. There are advantages of going there, but, again, the satellites have to be ready. It is satellites that drive the launch business, not the rockets. If the satellites are there, then the launch industry will respond to it.

Mr. FORBES. Good. Thank you.

Mr. Loverro, how are DOD space procurement policies taking into account the opportunities that newer orbital launch facilities like Wallops and Kodiak provide, and how can Congress support efforts to make sure these launch complexes are available to support small- and medium-class defense launch needs?

Mr. LOVERRO. Sir, I think most of the policies that the administration has put forward definitely support both commercial and State-sponsored launch capabilities. So you have seen a proliferation, we have talked about Kodiak and Wallops today, but there are no less than 6 different States that have filed for space launch ports authority.

I think this is a great example of the competitive nature of space launch and I think that this is a place that we should allow that industry to flourish by, again, encouraging the commercial world and the States to go ahead and make those investments.

I will tell you, I agree with everything that General Hyten says, but I would also harken back to the question of what is the launch industry going to look like in the future that we answered when we talked about launch vehicles.

If we don't have a large commercial space industry, if we only have the government space launch capability, we also can't maintain economically more than a couple of launch sites, so—because launch sites are not free. They are just not pads that sit there by themselves. They have to be maintained. So there has to be enough

throughput. And that goes back to what General Hyten said, you need—the satellites drive the launch infrastructure. Launch infrastructure doesn't drive the satellites.

Mr. FORBES. Gentlemen, thank you.

And with that, Mr. Chairman, I yield back.

Mr. ROGERS. I thank the gentleman. The Chair now recognizes the gentleman from California, Mr. Garamendi, for 5 minutes.

Mr. GARAMENDI. Thank you, Mr. Chairman. Gentlemen, thank you very much for your testimony. And I wish we had several hours to go through it.

General Hyten, is the Air Force and the military dependent upon GPS for virtually everything?

General HYTEN. I think the world is dependent on GPS. The military certainly is. We have built an amazing capability that fundamentally changed warfare. All precision warfare—most all precision warfare today is based on GPS. We still have laser-guided munitions that we drop in certain areas, but most of the munitions we drop are GPS-guided. Most of our operations are GPS-fed. The timing signal that comes off GPS in some ways is more important than the navigation signal. So we are unbelievably——

Mr. GARAMENDI. In fact, the ATM [automated teller machine] won't work without the timing——

General HYTEN. Your ATM won't work——

Mr. GARAMENDI. No——

General HYTEN [continuing]. Gas, stoplights stop working.

Mr. GARAMENDI. Do all of you gentlemen agree with that? You know, it is like—it has been said that GPS is the single point of failure, is that correct, for virtually everything that you have talked about here?

General HYTEN. It could be looked at as a single point of failure, but one of the things that we do is we build resiliency into our weapons systems, we have a backup inertial navigation system that we use in most of our weapons systems to allow us to do that. Nonetheless, GPS is a vulnerability, so we are looking at a number of different ways, we can talk about that in the closed hearing in more detail, but a number of different ways to ensure that we can continue to operate in a GPS-denied environment.

Mr. GARAMENDI. Have you considered terrestrial-based timing?

General HYTEN. There are a number of terrestrial-based timing sources that are out there. eLoran [Enhanced Long Range Navigation] is one of the ones we are looking at across the coast. That is not a DOD system, but the Department of Transportation and the Coast Guard, in particular, are looking at that. That has significant benefits around our ports to reduce vulnerability of GPS.

But in order for eLoran to work, there has to be eLoran receivers that can take the signals off of eLoran, because if you build eLoran and there are no receivers, it would be like building GPS without the GPS receiver.

Mr. GARAMENDI. Are receivers possible to be built?

General HYTEN. Yes, they are. But, again, somebody has to invest in that money. The GPS market blossomed because there was a huge commercial market. The question you have to ask yourself for eLoran, and that is for somebody that is not on this panel, that is the Department of Transportation question. But what is the

marketplace that will come for eLoran? It is probably shipping, those kind of people.

Mr. GARAMENDI. Let's see. The Department of Defense is for defense?

General HYTEN. Department of Defense is for defense, absolutely, and that is why we are——

Mr. GARAMENDI. So if somebody wanted to knock out our electrical systems or our communication systems or our financial systems, they would knock out the GPS, wouldn't they?

General HYTEN. They would.

Mr. GARAMENDI. Is that a defense issue?

General HYTEN. That is a defense issue. That is why we look at that, that is why we are part of the national—Positioning, Navigation and Timing EXCOM [executive committee].

Mr. GARAMENDI. Why did you write me a letter saying that there is no role for the Department of Defense for the eLoran system? Why is the Department of Defense not willing to spend, like, I don't know, $50 million a year to provide the foundational backup system to GPS? Why did you write that letter to me?

Mr. LOVERRO. Sorry, sir. Is that to me? I didn't hear the—who. It was addressed to me?

Mr. GARAMENDI. Well, your name was on it, so——

Mr. LOVERRO. Yeah. Okay. No. I just didn't hear if you said that was to me or not, so—sir, so there was not—so we do not have a Department of Defense requirement for GPS. You do know, and I——

Mr. GARAMENDI. Well, we just established the fact that GPS is a—that the absence of GPS is a defense issue.

Mr. LOVERRO. Yes, sir. There are many issues that trans—that go ahead and transition from defense issues to national security issues. I would go ahead and——

Mr. GARAMENDI. Ah, the Department of Defense is not a national security issue?

Mr. LOVERRO. No, sir. I——

Mr. GARAMENDI. Is that what you are saying to me?

Mr. LOVERRO. I absolutely agree it is. As you know, I have told you that I wanted to look into this question more. I have done that. I still owe you a written paper on this, I understand.

My sense is that eLoran is one of several capabilities that could help this issue, but I think the point that——

Mr. GARAMENDI. And the other ones are?

Mr. LOVERRO. The other ones are better GPS or GNSS [global navigation satellite systems] user equipment, local time sources. And, in fact, in many cases it is a combination of all three.

Mr. GARAMENDI. Are they available?

Mr. LOVERRO. Yes, sir, they are, because, in fact, the DOD is—in our own timing infrastructure, those are the kind of backups that we are putting into our infrastructure.

The point that General Hyten, though, made is very important and I think it is instructive. You may not know that when we created the newest version of GPS, we created a second civil signal called L2 based upon the President's direction back in 1996, because many people believed the commercial world would adopt it.

There are no L2 receivers available in the world today, because nobody feels it necessary to listen to the second civil signal.

So I think their concern isn't so much what is the source of timing, which eLoran would be a good and appropriate source for the continental United States; I think the question is how do we make sure people adopt the receiver infrastructure to go ahead and make the source?

Mr. GARAMENDI. I have got no time left, but let me just pose this question. You can send it to me in writing along with the other information you promised.

Mr. LOVERRO. Yes, sir. I absolutely will.

Mr. GARAMENDI. Have other countries and other parts of the world established a ground-based terrestrial timing system?

Mr. LOVERRO. Sir, as a matter of fact, they did, and they have shut them down, because——

Mr. GARAMENDI. All of them?

Mr. LOVERRO. Yes. France, Norway, and——

Mr. GARAMENDI. Russia and China?

Mr. LOVERRO. Russia has a different system. I don't know about Russia's status, but France, Norway, and the U.K. [United Kingdom] have shut theirs down because of a lack of users. So the same problem that we——

Mr. GARAMENDI. That is a longer question.

Mr. LOVERRO. Yes, sir.

Mr. GARAMENDI. I will get into it with you again.

Mr. LOVERRO. Yes, sir.

Mr. GARAMENDI. Thank you, Mr. Chairman.

Mr. ROGERS. I thank the gentleman.

The Chair will point out now we have been called for votes. We are going to recognize Mr. Bridenstine from Oklahoma for 5 minutes, and then we will recess and come back after this series of votes, which will be about 1 hour from right now.

The gentleman from Oklahoma is recognized.

Mr. BRIDENSTINE. Thank you, Mr. Chairman.

General Hyten, the Air Force has requested funding for a wideband SATCOM AOA [analysis of alternatives]. I think that is perfectly appropriate. And then we received information in news reports about the Air Force purchasing additional legacy satellites, WGS [wideband global satellite communications] satellites.

How do we make sure that we, as a country, are taking advantage of the technological advances happening in the commercial sector? Of course, the AOA is what I thought that was what that was for, and now it doesn't necessarily appear that that is going to be the case. Can you share with us how you plan to make sure that we are taking advantage of the commercial advancements?

General HYTEN. Yes, Congressman. Thank you for the question.

The real issue there is that the AOA is going to answer those questions. We have not made a commitment yet to build any more WGS satellites, not one, not two, not three. We haven't made any commitment along those lines. We won't make any commitments about what we are going to build next until we have done the analysis of alternatives.

The analysis of alternatives is being structured through the staff right now. One of my panel members may be able to comment on

those, especially those that work in the Pentagon. But it is critical that that AOA look at it across the board, and we are going to be demanding customers of the AOA to make sure that the commercial sector is properly looked at across the board, not just from a provision of capabilities standpoint, but from an opportunity to provide different capabilities that we may not think about.

So that AOA is critical to defining the future. We are putting those—we want to make sure that that is done in a very time certain environment. We hope to get it done by March the 17th so we can meet the congressional direction there. That is going to be a fast time to do an AOA, but the faster we do AOAs, the better they are, because AOAs that take a long time tend to be somewhat irrelevant by the time they are reported out.

Mr. BRIDENSTINE. Got it.

And, Secretary Loverro, we have heard cost estimates from commercial operators and, of course, from the Department of Defense on WGS, and it doesn't seem to add up that we are getting apples-to-apples comparisons. Can you help us make sure that we are going to get apples-to-apples comparisons on the cost of commercial, vice military-owned and operated satellites?

Mr. LOVERRO. Sir, absolutely. We have got to go ahead and do an apples-to-apples comparison. We have got to go ahead and include all the costs that are relevant to things like WGS. That is not always easy to do, because some of those costs are at third and fourth level, but we have to go ahead and do that, because otherwise we will get a skewed result from the analysis.

Mr. BRIDENSTINE. Okay. And, Secretary Loverro, in January in an interview with SpaceNews, you suggested that a civil agency should perform certain day-to-day nonmilitary space situational awareness [SSA] activities for commercial and foreign operators.

Specifically you stated that, quote, "The JSpOC's primary role should be to support U.S. and allied military space operations," unquote.

Do you support building the capability of a civilian agency to obtain space situational awareness data and perform limited SSA activities for commercial and foreign operators?

Mr. LOVERRO. Congressman, I do. So this is obviously a very important question. The DOD is not going to go ahead and give up our ability to go ahead and do SSA for our warfighting mission.

At the same time, we recognize that to fully support our commercial industries, we need to go ahead and put that on a more civil footing, one that not only can go ahead and do space traffic monitoring, which is what we do from the JSpOC today, but some level of space traffic management. The Congress recognized this in their legislation last year, and I think we recognize it as well.

So I know with my colleagues up here, we are all trying to figure out what the right balance is between that, how do we do that. I think we all believe this has got to start off with a crawl, a walk, and a run, which we would believe would begin with putting probably FAA [Federal Aviation Administration] personnel out at the JSpOC to help that function, but we recognize that the future is going to require that a civil agency take over this far larger and growing sector than we should support from the DOD.

Mr. BRIDENSTINE. Thank you.

And, General Hyten, as the commander of Air Force Space Command, is performing space traffic management for the entire world in your mission statement?

General HYTEN. No, sir, it is not.

Mr. BRIDENSTINE. If a civil agency were to perform some space traffic management activities for non-DOD customers, would that make it easier or harder for airmen at the JSpOC to focus on deterring, fighting, and winning wars in space?

General HYTEN. That would make it easier, but I do have one comment about that, is that it is not in our mission to do those things, but what you have to realize is that we have to do those things in order for us to operate safely.

So it is critical that we continue to perform the space situational awareness mission and critical that we have the ability to integrate that into all of our operations, but nonetheless, the ability to do space traffic management, like Mr. Loverro described, is not in our mission statement. We do it because we have to do it. Somebody has to do it for the world, but it is more a civil function than it is a military function.

Mr. BRIDENSTINE. Fantastic. I have got just a few seconds left, and so we will just take this for the record.

Space and Missile Systems Center released an RFI [request for information] seeking input from industry on commercial weather data and services to meet DOD requirements. And basically it is a policy to buy data from the commercial sector to feed our numerical weather models and predict weather.

Could DOD benefit from following NOAA's [National Oceanic and Atmospheric Administration's] pilot program approach to begin the process of establishing standards, testing integration, and eventually buying data and services for weather purposes?

General HYTEN. We will take it for the record, sir, but the answer is yes. We are going to use all data capabilities that we can. But we will take that and give you a detailed answer for the record.

[The information referred to can be found in the Appendix on page 111.]

Mr. BRIDENSTINE. Okay. Thank you, Mr. Chairman.

Mr. ROGERS. I thank the gentleman.

The Chair now calls that we will be in recess until about 4:40, when we will return to this room.

[Recess.]

Mr. ROGERS. The Chair calls the meeting back to order and recognizes the gentleman from Louisiana, Dr. Fleming, for 5 minutes.

Dr. FLEMING. Thank you, Mr. Chairman.

General Hyten and Mr. Weatherington, what is the Air Force's plan for ensuring optimal U.S. investment to replace the Russian RD–180 engine?

General HYTEN. So I can talk about the top level, and then I will let Mr. Weatherington talk about the acquisition strategy.

But our basic overall plan is to develop public/private partnerships with industry to leverage the capability that we need to ensure that all the capabilities we need, for the future launch enterprise, exists when we need them, not just as soon as possible, to get off the RD–180.

So that includes first-stage engines, it includes upper-stage engines, it includes solid adjunct boosters as well as the solid main core. So we are looking at the entire enterprise to make sure that the enterprise will be ready when we get there.

Mr. WEATHERINGTON. Yes, Congressman, I think it is also important to point out that for the U.S. Department of Defense, we do not procure actual launch systems. We procure that service. So the plan for the Department moving ahead, is to incentivize industry to partner with us to develop launch capability that will meet the full manifest requirements that DOD has.

Now, as General Hyten has indicated, there are several different technologies that we need to invest in to get there. We need both main-stage engines, and we need upper-stage engines. But fundamentally, we need an integrated solution that will launch our satellites.

Again, as General Hyten said, it is about the satellite, and the rocket will follow. So the strategy the Department has is to incentivize team in public/private partnerships with various commercial entities, either rocket integrators or in some cases specific subsystems.

And the Air Force has done a great job of structuring the other transaction authority activities currently underway to go out and invest in those critical technologies we need with the plan that every one of those has a path to get to a rocket integrator and deliver us an integrated solution, likely in the 2019, 2020, 2021 timeframe.

Dr. FLEMING. Are the specifications superior to the Russian RD–180 engine? In other words, do we end up with a better product if this flows properly?

Mr. WEATHERINGTON. Well, again, sir, because we are not actually buying a rocket or even buying an engine, what DOD requires is a requirement to launch our full manifest. So today, as I think you are aware, we have two systems certified to do that today, Atlas and Delta, several variations of each of those systems, but they cover the entire manifest.

Delta IV Heavy, which we use for our largest systems, is a fairly expensive system. Our goal in the development of these future launch systems is to bring that cost down, especially at the high end.

Dr. FLEMING. Uh-huh. Okay. And how do we maintain assured access and protect the taxpayers as we transition off that engine, the RD–180?

General HYTEN. So that is why our recommendation, sir, is to allow us to buy enough RD–180s to cover us through the transition period, because that will be significantly less cost to the taxpayer. As we talked about earlier, we don't know for sure what the cost will be if we go a different direction, for example, a Delta-Falcon mix.

If we go a different direction, I believe that the cost will be measured in the billions. The Secretary stated that the estimates are up in $1.5 billion to $5 billion. That is true, but that spread in the estimates are all based on the assumptions. So if you make certain assumptions about where the industry is going to be, you can drive that answer to wherever you want. But I am confident that it will

be a significant bill to the taxpayer if we need to do something in the transition period.

But again to emphasize the point, we want off the Russian engine as fast as we can get, and that is why we put the program in place that we have.

Dr. FLEMING. Okay. Thank you. I yield back, Mr. Chairman.

Mr. ROGERS. I thank the gentleman.

I believe the gentleman from Colorado is next up for 5 minutes.

Mr. COFFMAN. Thank you, Mr. Chairman.

General Hyten and Lieutenant General Buck, can you discuss how funding for the 460th Space Wing and 233rd Space Group are prioritized within Air Force Space Command and JFCC Space [Joint Functional Component Command for Space]? Is it a top priority? Do you have any concerns that funding priorities will negatively impact our missile warning mission?

General HYTEN. So, I guess, the easy answer to that question—and I will let General Buck weigh in, but the easy answer is that missile warning is a survival mission for the Nation. So a strategic missile warning has been and will continue to be the highest priority mission that we have in Space Command. That is the mission of the 460th Wing, part of the mission of the 233rd.

So as we look at those capabilities in the future, that will continue to be a high priority.

General BUCK. And the good news there, sir, is that we are putting some money into the infrastructure up there, as you know. We just replaced the UPS [universal power supply] up there because we had power issues, as you are tracking them, I am sure, not only in the survival of mission control center but also in the primary mission control center. So we have got our eye on the ball there, and we are very aware of how critical that mission is to the warfighter.

Mr. COFFMAN. Okay. General Hyten, can you discuss a level at which the Air Force makes cost, schedule, and performance trade space decisions related to missile warning. Are there any instances where the Air Force and STRATCOM would have to sacrifice national missile warning responsiveness in order to reduce cost?

General HYTEN. So we will never trade off the strategic missile warning mission, because that is a survival of the Nation issue. So that can't be traded off. There is a discussion worth having about how much of the secondary missions you get from Overhead Persistent IR [infrared], in other words how much battle space awareness, how much technical intelligence, how much capability that you want to build.

There is also an issue about how do you want to provide that capability. But the fundamental strategic missile warning capability that we have to have as a Nation cannot be traded off, and the commander of STRATCOM has told me that in person. And those capabilities will not be traded. That is a survival of the Nation issue.

Mr. COFFMAN. Okay. Mr. Cardillo, last year, you released your commercial GEOINT [geospatial intelligence] strategy, which outlines how you intend to leverage our commercial space imagery, services, and analysis. Can you tell us what progress you are making so far this year, and can you tell us how your fiscal year 2017

budget request further enables your successful implementation of the strategy?

Mr. CARDILLO. We are in the learning and investigation phase of that overall strategy. We are doing it with our mission partner at the NRO, because whatever we end up deciding to do from that commercial market, as it matures and becomes viable, we are going to have to share how we store that data, how we move it around, how we intermingle it with our classified systems. And we can talk more about that in closed session.

I have been very pleased with the reaction that we have gotten from industry to date. And so we are making small purchases to understand data types, and sensor types, and what kind of imagery sources they are collecting. As we learn more, but I must say too, as they become more commercially viable to create that market, we do intend, and in fiscal year 2017, pending Congress' budgeting, is to expand our ability to exploit that space.

Mr. COFFMAN. Mr. Calvelli, in your written statement, you mentioned that NRO is improving space-based persistence, creating a, quote-unquote, "thinking system" called Sentient and developing a transformative future ground architecture. Can you discuss how Buckley Air Force Base and the Aerospace Data Facility, ADF–C [Aerospace Data Facility-Colorado], fit in these efforts?

Mr. CALVELLI. Sure. All of our ADFs are a major piece of how we operate our systems today and will continue to be for the future. What we are trying to do is to try to tie our systems together more closely, so instead of stovepipes of GEOINT or stovepipes of SIGINT [signals intelligence], it is sort of an integrated set of sensors in space, integrated ground providing data to our user community. The ADF–C, ADF–E [Aerospace Data Facility-East], ADF-Southwest will all play major roles in that in the future.

Mr. COFFMAN. Thank you, Mr. Chairman. I yield back.

Mr. ROGERS. I thank the gentleman.

I believe the gentleman from Oklahoma has one cleanup question. Is that what I was told?

Mr. BRIDENSTINE. I have got a couple——

Mr. ROGERS. Knock yourself out.

Mr. BRIDENSTINE. I wanted to ask, General Hyten, Air Force budget documents state that you will conduct an end-to-end over-the-air demonstration of protected tactical waveform [PTW] in mid-2019. The Air Force apparently delayed the initial launch capability of protected tactical service [PTS] by 3 years until 2027. What factors account for the delay to PTS, and why is there an 8-year gap between full-up PTW demo and ILC [initial launch capability]?

General HYTEN. So the answer to the question, Congressman, is that we have yet to complete the protected SATCOM communication system AOA, the analysis of alternatives. Before we can start a program within the Department, we need to complete the AOA. The AOA is imminent. We have completed it. Mr. Kendall, the Under Secretary for Acquisition, Technology, and Logistics, has signed off on it, pushed that into CAPE [Office of Cost Assessment and Program Evaluation]. CAPE is now doing the sufficiency study. They have committed to completing that by April 15.

But as we submitted our budget documents, we had to make some assumptions of what we thought the future was going to be. And to us, it looked clear that protected tactical waveforms will be part of the architecture in the future; therefore, it was important for us to pursue the pathfinder that you saw in the budget documents. And then the rest is to be determined.

So we don't want to put a program in place without the proper analysis having been completed, and that will be complete here very shortly. And we will share that with the Congress when it is complete.

Mr. BRIDENSTINE. Okay. Last question, I have been told that prior to this RD–180 issue, a new low-cost, upper-stage engine replacement had been a high priority for your national space security launch needs. If this is true, how do you plan to address the upper-stage replacement, and is there a way to couple the development of this upper-stage engine, such as those already funded and developed through the Small Business Innovation Research program, in a matter that benefits replacement of the RD–180?

General HYTEN. So in the contracts we just let with industry, in those contracts, in those other transactional authority contracts, there are two pieces of it that look at upper stages.

One is with SpaceX for their Raptor upper stage, and one is with the ULA [United Launch Alliance] for their ACES [Advanced Cryogenic Evolved Stage] upper stage. Both of those are required in their business plan in the future to allow them to access all the orbital requirements that we have to launch our entire manifest.

So as you stated, the upper stage is extremely important. We have recognized that for a long time, long ahead of the RD–180 issue. It is a challenge though to get the capabilities that we need out of those upper stages, but if we do it correctly, we will be able to move into a different architecture for the future that will be much more efficient because the upper stage will be more efficient in achieving multiple orbits.

Mr. BRIDENSTINE. And the last question, if the chairman will allow me, and this is for you as well, General Hyten, how does EGS relate to the requested protected tactical enterprise service?

General HYTEN. EGS being the enterprise ground system?

Mr. BRIDENSTINE. Yes, enterprise ground service.

General HYTEN. So the enterprise ground capability, as we look at the protected tactical waveform, what we are trying to get to with enterprise ground is we are trying to structure the process so that we can operate our satellites, perform telemetry tracking and controlling off of a common infrastructure in our ground system, so we can have our operators focus on providing the warfighting effect to the world to our entire force structure across the board as we look at that.

So it is important that we move into an enterprise ground structure because that will free up our airmen to effectively operate the protected tactical waveform in a threatened environment as we go through. It is not that we can't do it on the legacy; we will be able to do it on the legacy, but in order for us to fully use our airmen capabilities, we need to structure the program so that we are focused on the effect that we are creating on the battlefields of the future, not on just flying the satellite.

Mr. BRIDENSTINE. Got it.

Thank you, Mr. Chairman. I yield back.

Mr. ROGERS. The gentleman from Colorado has one cleanup question.

Mr. COFFMAN. Thank you.

Mr. Calvelli, and Mr. Cardillo, and General Hyten, are NRO, NGA, and Air Force Space Command getting what you need from Buckley Air Force Base in the city of Aurora? Is there anything else Congress can do to support your efforts at ADF–C?

Mr. CALVELLI. I will start and say, I think, we are in great shape out at ADF–C, and appreciate all the support out there from Aurora and the whole town.

Mr. CARDILLO. Mr. Calvelli is my landlord. I am a happy tenant. We are very pleased with the support we get from Buckley.

General HYTEN. And the 460th is everybody's landlord. And, you know, the whole issue recently about encroachment was a big concern of ours. That was just addressed this last week when we looked at the adjacent land and how we are going to deal with that in the future. That was the one, big issue that was hanging out there for Buckley, because, in many of our bases in the past, we have had encroachment issues that have really impacted our mission. I think the actions of the last week with the land around Buckley have really gone a long way to solving that problem for a very, very long term, perhaps forever. And that is where we need to be.

So thank you, Congressman, for that help there.

Mr. COFFMAN. Thank you, Mr. Chairman.

I yield back.

Mr. ROGERS. I thank the gentleman.

General Hyten, can you tell us about the status of the DMSP–19 [Defense Meteorological Satellite Program flight 19]?

General HYTEN. So the DMSP–19 is about dead. That is about as blunt as I could put it. A few weeks ago we lost the ability to command the satellite. The way DMSP satellites operate is they still broadcast tactical information, but we can't get the recorded information down to our users because we can't task the satellite, we can't command it anymore.

When we can't command it anymore, that also means we can't take care of the satellite's health, keep it pointed in the right direction, keep it safe. So in the very near future, if we can't command it again, we will lose the satellite forever.

Mr. ROGERS. So should we launch DMSP–20?

General HYTEN. In a perfect world, Congressman, I would prefer to launch DMSP–20, but we received direction from the Congress last year to terminate that program. General Greaves in Los Angeles issued the order to terminate on the 30th of December, 2015. We are in that process. We will reach the point of no return in June of this year; that, after that point, the satellite will be torn apart and not able to be put back together.

So I said last year in testimony that it was a difficult decision to recommend whether we wanted flight 20 or not, but we ended up recommending to the Congress that we launch flight 20. I wish I would have been stronger in that, because the statement I made

is that we need it if we have a failure, and it appears now we have had a failure.

Mr. ROGERS. Well, if it is important to get that capability up there, why isn't the Air Force working on a follow-on program to meet that capability?

General HYTEN. So we are working on a follow-on program—it is called the weather satellite follow-on capability—to meet the three elements of the needs. We also have a new tasker from the Joint Requirements Oversight Council, the JROC. General Selva sent us the tasker this last week to look at the first two gaps, which are cloud characterization and theater support; report back to him by the 1st of May whether the capabilities we have right now, given all the changes, will be able to support the requirements that we need. In that memo, he also supported the launch of DMSP flight 20.

Mr. ROGERS. Great.

General Hyten, I am concerned about the loss of our transfer of spectrum and the impact on national security, particularly when I hear the chairman of the FCC [Federal Communications Commission] telling the satellite industry that, quote, "it is more practical to get on the train than being run over by it," close quote.

You may recall that your predecessor, General Shelton, testified from pretty much where you are seated right now and warned that a proposal under consideration by the FCC would have created extensive, harmful interference to GPS. Can you please describe for me your views on the proposal by the LightSquared or the company LightSquared or its successor Ligado?

General HYTEN. So I have heard Ligado has put forth a new proposal to use that spectrum. But I will tell you, Congressman, I have seen no data that supports the use of that frequency spectrum other than the data I saw in 2011. So the position of Air Force Space Command is the same as it was when General Shelton sat in that seat.

I don't think that we should infringe on the GPS spectrum. That is a critical capability, not just for the military security of the Nation but for the entire economic well-being of this Nation. We can't allow that to happen.

All that being said, is that we have an effort with the Department of Transportation in April of this year that we are going to go out and do some detailed testing on that spectrum area. We will then have a peer review in May and June of this year, and then we will go through a process where we will look at it and see what elements of those spectrum.

Because we are trying to be good partners as we work at that, but the partnership has to be based on real testing, real impacts, and what the impacts on the national security are. And we cannot do something that will infringe on our national security, period.

Mr. ROGERS. All right. That brings the open portion of this hearing to a conclusion. We will now recess briefly while we move upstairs to 2216 for the classified portion.

[Whereupon, at 5:01 p.m., the subcommittee proceeded in closed session.]

A P P E N D I X

MARCH 15, 2016

PREPARED STATEMENTS SUBMITTED FOR THE RECORD

MARCH 15, 2016

Opening Remarks
Honorable Michael D. Rogers
Chairman, Subcommittee on Strategic Forces
House Armed Services Committee

Hearing on Fiscal Year 2017 National Security Space Activities

March 15, 2016

Good afternoon. I want to welcome everyone to the Strategic Forces Subcommittee's hearing on the Fiscal Year 2017 National Security Space activities of the Department of Defense.

We are honored to have a panel of experts who lead various areas of our national security space enterprise. The witnesses are:

General John Hyten
Commander, Air Force Space Command

Mr. Douglas Loverro
Deputy Assistant Secretary of Defense for Space Policy

Mr. Dyke Weatherington
Acting Deputy Assistant Secretary of Defense for Space, Strategic and Intelligence Systems

Lieutenant General David Buck
Commander, Joint Functional Component Command for Space

Mr. Robert Cardillo
Director, National Geospatial-Intelligence Agency

And,

Mr. Frank Calvelli
Director, National Reconnaissance Office

After we finish with the unclassified testimony and questions and answers, we will adjourn to a closed session to continue our oversight in an appropriately secure fashion.

This is a large panel of witnesses, and we ask each of you to testify at this hearing because of the key role you have regarding national security space. However, seeing such a big panel on this subject may be indicative of the fragmented management of space.

For instance, a 2008 independent commission reported that "there's no one charge" of national security space and stated that "without significant improvement in the leadership and management of National Security Space programs, US space preeminence will erode to the extent that space ceases to provide a competitive national security advantage."

The issues that were raised, and the recommendations made, by the previous commissions continue to be timely…as we face unprecedented threats in national security space.

However, I recognize that changing a bureaucracy is a difficult undertaking, and even more so when you are part of that bureaucracy.

But we have to get this right because we cannot risk our space assets. I do not intend to focus on organization and management much today but I'd ask that each of you consider our national security space construct and provide some feedback to the committee by April 1st as we consider the best step forward to ensure we have the world's leading national security space program now and long into the future.

Now, I'm going to change gears to another topic that you all know I am very passionate about … assured access to space. We are facing multiple challenges in this area, and I will not allow our space program to be put in jeopardy or the taxpayers to foot an unreasonable bill as we set the course for the future.

As I've said in the past, I know the men and women in our Air Force are trying their best to address the challenges facing our launch program, but I simply do not agree with the path it is attempting to take us down with regard to the replacement of the RD-180 Russian engine.

I am extremely concerned that the Air Force is taking on too much risk in what may amount to be a very expensive endeavor, while repeating many of the mistakes of the 1990s when the EELV program began.

Rather than directly addressing the Russian rocket engine problem we have, the Air Force is trying to recast the entire EELV program in a quest to create the ultimate competitive commercial industrial base.

Now, of course Congress doesn't want a rocket engine alone that won't get us into space. No one does; and any suggestion to the contrary is a strawman. We recognize that an engine can't just be dropped in a launch vehicle without any interface work.

This is why the law in FY 16 specifically allowed the integration of a rocket propulsion system with a launch vehicle.

But just because an engine can't be dropped into an Atlas doesn't mean we should just start over on the EELV program.

I will to offer this chart for the record from the former Administrator of NASA, Dr. Mike Griffin which identifies launch vehicles that have been re-engined. This is a well understood process.

And this is why the past two NDAAs prohibited government funds to be used to develop new launch vehicles or new infrastructure … because we've already invested in that.

I look forward to talking about this more with you today, and thank you all for being with us regarding this important topic.

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SUBCOMMITTEE ON STRATEGIC FORCES
HOUSE ARMED SERVICES COMMITTEE
US HOUSE OF REPRESENTATIVES

DEPARTMENT OF THE AIR FORCE

PRESENTATION TO THE
SUBCOMMITTEE ON STRATEGIC FORCES
HOUSE ARMED SERVICES COMMITTEE
US HOUSE OF REPRESENTATIVES

SUBJECT: National Security Space Budget for FY17

STATEMENT OF: General John E. Hyten
Commander, Air Force Space Command

March 15, 2016

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SUBCOMMITTEE ON STRATEGIC FORCES
HOUSE ARMED SERVICES COMMITTEE
US HOUSE OF REPRESENTATIVES

Introduction

Chairman Rogers, Ranking Member Cooper, and distinguished Members of the Committee, thank you for the opportunity to appear before you today to discuss how we deliver space capabilities to our nation's warfighters. It has been my distinct privilege to lead and represent the nearly 36,000 dedicated men and women of Air Force Space Command (AFSPC), who serve at 134 locations around the world, and provide foundational space capabilities vital to the protection of the Nation.

As this committee is well aware, space capabilities are essential to our way of life and a central responsibility of the Air Force's mission. In addition to the vast commercial utility of this Nation's space assets, military planners leverage the use of space capabilities to enhance the effectiveness of our military forces whether they are in training, engaged in humanitarian assistance, countering terrorist organizations, deterring aggression or conducting combat operations.

The purpose of my testimony today will be to highlight the activities the Command is pursuing to assure access to space, the better business practices the Command is embracing and our preparations to build in operational resilience if a war were to extend into space and threaten our capabilities.

Assured Access to Space

In 2015, the Air Force successfully launched eight (8) National Security Space Evolved Expendable Launch Vehicles (EELVs) delivering critical space-based communications, navigation, and reconnaissance capabilities to our joint warfighters and national decision makers. Space is not just an enabler for the other operational domains; it directly impacts the calculus of

national security. However, these capabilities are impossible unless we maintain our assured access to space and promote a vigorous space launch industrial base.

The Air Force will comply with all federal statutes governing our national launch policy. This includes the procurement of competitive launch services necessary to maintain assured access to space, our efforts to transition from the use of non-domestic propulsion systems, and the continuance of thorough mission assurance and certification processes that preserve focus on mission success while encouraging a robust and competitive industrial base.

The challenge before us is to ensure space services remain available to joint warfighters at the time and place of our choosing while operating in an increasingly contested space domain. The first step in this process is to assure our ability to provide safe and reliable access to space for national security payloads. We must preserve assured access to space while driving down costs and taking into account schedule, risk, affordability and competition among providers.

Launch as a Service

It is important to note that our approach to space lift fundamentally changed with the shift to EELV. That is, the Air Force no longer owns the vehicles that we launch or the associated infrastructure; instead, we purchase access to space as a service. Industry is investing large amounts of private capital in developing new engines, launch vehicles, and infrastructure, and we are collaborating closely with them to determine how best to invest in public-private partnerships toward launch services that use U.S.-made launch systems.

A robust and diverse industrial base that can deliver launch capabilities safely and at a competitive price is central to assuring access to space and in our government's best interest. Nevertheless, launch is a risky and difficult business. We must encourage a business model with

our industry partners that is stable, predictable and able to respond to launch failures without collapsing.

Launch Service Investment

I believe it is critical that our Nation move expeditiously to eliminate use of the Russian RD-180 rocket engine. Uncertainty regarding its future availability results in increased risk to our national security space (NSS) posture. With the support of Congress in prior years, the Air Force is investing nearly $500 million in rocket propulsion systems through technical maturation, risk reduction and innovative partnerships with industry to invest in the rocket propulsion systems they need for their commercial launch systems.

Last year, the Air Force informed Congress of its plan to transition off the RD-180, while preserving assured access to space, supporting full and open competition and maintaining our current high degree of mission assurance. During Technical Maturation and Risk Reduction efforts, $60 million of the $220 million appropriated in FY 2015 and $41.77 million in re-programmed FY 2014 funding went toward technical maturation and risk reduction efforts to address high risk rocket propulsion technologies in the following four key categories: material and manufacturing development; advanced technologies; modeling and design tools; and critical component design, integration and testing. The remaining $160 million of FY 2015 funding, and a portion of the FY 2016 funding, have been invested in industry's rocket propulsion systems. These competitive awards invest in up to four rocket propulsion systems that industry plans to use in developing future launch solutions. The FY 2016 NDAA authorizes the use of $228 million for rocket propulsion systems and integration between rocket propulsion systems and launch vehicles. Starting with our FY17 budget, the Air Force plans to leverage these rocket propulsion systems to quickly shift towards one or more new or upgraded launch systems that

industry will use to provide our future launch services. The goal here is two or more domestic, commercially viable launch providers that also meet all NSS launch needs no later than 2022 or 2023. This phase of the process may include future launch service commitments in order to reduce up-front Government investment in new or upgraded capabilities. In the meantime, the Air Force will transition to procuring Phase Two launch services (procured from 2018 to 2022 for launches from 2020 until 2024) from existing certified systems to new certified systems in as competitive a manner as possible.

While the Air Force is funding engine technology maturation of liquid rocket engines, fully funding the development of a new engine alone is not sufficient to replace the RD-180. I must emphasize that in order to maintain the current capability; any new engine still has to be integrated into a modified launch system. More importantly, we do not want to be in a position where significant resources have been expended on an engine and no commercial provider has built the necessary launch vehicle. Even if the rocket is similar to, or based upon, any of our existing launch vehicles, any change needed to integrate a new engine still requires engineering, comprehensive testing, and certification which will likely take another year or two. Our analysis shows that an engine-centric approach would cost $2 billion more than and take just as long as the launch services public-private partnership approach that we prefer. That is why the Air Force intends to pursue a launch service approach to transition off the RD-180. There are significant risks to pursuing development of an engine alone. To that end, we continue to explore partnerships with industry so that our nation's investment in a new engine will not go to waste. Early partnering increases likelihood of developing a system that is both competitive on the global commercial market and capable of meeting all NSS requirements.

A strategy of shared investment with industry using private-public partnerships is absolutely imperative because it ensures industry shares some of the cost burden, it offers the best chance of solving substantial technical challenges and it provides the opportunity to harness industry's creative ideas in ways to achieve propulsion and launch system performance requirements. It will be a significant challenge, but we believe with the efforts and ingenuity of our government and industry teams, it is possible to develop an American engine by 2019 and have at least two domestic, commercially-viable, certified launch providers in FY 2022 or 2023 capable of meeting all of our national security space launch needs.

Competition in Launch

A key element of assured access to space is a healthy industrial base that promotes competition while emphasizing mission assurance. An important part of this strategy is our ability to expeditiously certify new entrants to the national security launch enterprise.

Last year, under the leadership of Lieutenant General Sam Greaves, Air Force Program Executive Officer for Space and Commander of the Space and Missile Systems Center (SMC), SpaceX was certified as an NSS launch service provider. This milestone means we have added another credible, certified launch service provider to go along with the compliant United Launch Alliance's (ULA) Atlas and Delta rocket families to support our critical NSS missions. After certification of the Falcon 9, SpaceX announced the Falcon configuration would be upgraded. I am pleased to relay that SMC has updated the baseline configuration of SpaceX's Falcon 9 Launch System to the Falcon 9 Upgrade for use in NSS missions.

Unfortunately, the Delta IV is not cost-competitive with either the Atlas V or the SpaceX Falcon 9. Accordingly, ULA intends to retire the Delta IV by 2018. The only exception will be the Delta IV Heavy variant, which is required to launch unique national security payloads. This

leaves us with a dilemma until the new launch systems, which we hope to help along with our launch system investments, are available in 2022 or 2023. To have assured access to space, we need two paths to space, to the maximum extent practicable, for all of our national security payloads, preferably in a competitive environment. This shared investment also frees up resources to address the many other challenges that we are faced with in space. However, until SpaceX completes and certifies the Falcon Heavy, the Falcon 9 only covers a portion of our manifest. Without access to the RD-180 engine, we can no longer use the Atlas V for our national security payloads. This leaves us in a transition period where can cannot provide assured access to space through the use of two domestic, commercially viable launch service providers for a significant portion of national security space payloads. I ask for Congress' help by providing the additional RD-180s needed to maintain our assured access to space in the near term, but no more than are necessary to allow us to transition.

Better Ways of Doing Business

The future of national security space requires we acknowledge, in a meaningful way, that impactful threats to our national security space capabilities exist and will continue to present significant challenges to our assured footing in this domain. We must be ready to defend our space assets and effectively deal with a number of challenges -- whether they present themselves through natural or man-made threats -- in order to accomplish our responsibility to organize, train, and equip space forces in defense of our Nation. This requires instilling operational resiliency in system capabilities and personnel in order to provide multi-domain effects to commanders and joint warfighters. If we cannot deliver all the advantages associated with space and cyberspace, joint warfighting capabilities become less effective and we risk going back to industrial-age warfare.

Operational Resiliency

During Operations DESERT SHIELD and DESERT STORM, the enemy did not have significant means to impact how we leveraged space and cyberspace for military advantage. We operated with near impunity in those domains, and for a long time since, we have continued to do so. This led us into an era where the chief concerns of major space and cyberspace programs were the cost and efficiency with which we could provide capability. This approach does not adequately account for today's potential threats and we cannot continue to acquire and operate space systems this way in the future. We now have the responsibility to acquire new *resilient* systems while keeping costs under control. We must not only continue to meet the needs of Airmen, Soldiers, Sailors, and Marines with space and cyberspace capabilities, but must field resilient space and cyberspace capabilities that allow our forces to respond to, and defend against, both naturally occurring phenomena and adversary action. I cannot stress this enough: competitors have the capabilities now to disrupt or deny our troops the advantages of our space and cyberspace capabilities. We must take steps now to account for this reality and make our space and cyberspace capabilities more resilient.

Partnerships

Operations conducted in the space and cyberspace domains require a robust industrial base to build, service, and equip the nation's defenses with the tools necessary to emerge victorious. We need technologies that guarantee service with regard to security. We need the capabilities to detect, attribute, defend against, and if need be to counter threat actors in both domains.

The DoD and AFSPC must partner with the same innovative thinkers that have grown the information technology industry to identify the right emerging technologies needed to ensure the

nation is secure in both space and cyberspace. Space and cyberspace acquisition can be -- no needs to be -- lightning fast in order to keep up with an ever-shifting technological environment and stay ahead of evolving threats.

I believe industry innovation will lead to dynamic solutions to the challenges of building resilient space and cyberspace architectures. It was government-sponsored research that led to the initial breakthroughs that launched both the space age and the Internet age. Now, academia and industry are leading the way in supporting both the government and commercial IT sectors. The DoD needs to leverage these rapid advances.

The military has sometimes dismissed industry models because they were based on profit at the expense of security. That is definitely not the case today. Industrial and commercial organizations are pushing the limits of technology to secure their business models in an increasingly competitive marketplace. We need professionals, from both the academic and private sectors, dedicated to developing and fielding innovative solutions to the nation's space and cyberspace security requirements. In combination with the Air Force's heritage of innovation, academia and industry will combine to generate new solutions on par with the groundbreaking innovations we have seen in the past.

The environment we now face in space and cyberspace is reaching a new tipping point. After years of post-Cold War stagnation, our adversaries have become re-energized and re-motivated to challenge our long-held advantage in both domains.

We must take decisive action now. We are stepping up with new ideas and new concepts to keep our edge and secure our nation's future. We are in a unique business, and we know we cannot achieve any of this alone. We need continued innovation and drive from our industry and academic partners.

Only a strong partnership with industry will ensure we succeed. We in the DoD spend approximately $3 billion annually on cyber security compared to the roughly $46 billion spent by industry. The adversaries that are trying to hack into our networks are the ones that are hacking into industry networks, and those of our allies. The question is how do we, as the DoD, capitalize on industry's investment? How do we gain synergies with industry and our allies to provide a safer operating environment and counter the actions of our adversaries? By developing and growing partnerships.

Centralized Asset Management

At the end of this fiscal year, AFSPC will complete the Air Force's centralization movement and transfer responsibility for all of our weapon systems sustainment (WSS) funding to Air Force Materiel Command's Centralized Asset Management (CAM) project office. The transfer of 21 Program Groups, totaling approximately $1.5 billion in requirements and $1.1 billion in funds, will enable the Air Force to benefit from consolidation into one enterprise management portfolio.

Consolidation of AFSPC's WSS funds and applicable manpower to CAM will streamline and simplify the Air Force's WSS portfolio and reduce risk by spreading funding across the entire WSS portfolio. It normalizes space and cyber WSS funding with the rest of the Air Force, allowing Centers to execute funds directly from CAM, thereby enabling them to maintain funding-line integrity. This means we are better able to keep readiness funds within Air Force-recognized readiness accounts and assure we are in compliance with federal statute(s) and congressional intent.

It is important to note that throughout this process, AFSPC will retain its space and cyberspace oversight, to include responsibility over the logistics, requirements, and

determination process and program objective memorandum execution. AFSPC will continue to maintain decision control over all funding realignments and prioritization of funded and unfunded requirements through a relationship with the CAM project office.

Preparing for a War that Extends into Space

The United States is facing traditional threats who are utilizing modern technology. After decades of fighting counter-insurgency warfare, our Nation must be prepared for tomorrow's higher-end fight by leveraging new capabilities to create the environment necessary for victory throughout the space domain. Our initiatives in space control, Battle Management, Command and Control (BMC2) and organization of operational forces will posture the Air Force to mitigate risks of increased competition in space.

Space Control

Today, over 170 countries have access to some form of space capabilities, 11 countries have indigenous launch capabilities, and new satellites are launched just about every week. There are currently over a hundred U.S. military and intelligence satellites in orbit, providing critical national security capabilities. Our ability to freely use these capabilities and maintain freedom of access to space is eroding as the space environment becomes more and more congested and contested.

Not all space faring countries are friendly to the United States or agree to establish and observe international norms in the space domain. Adversaries are developing kinetic, directed-energy and cyber tools to deny, degrade and destroy our space capabilities. They understand our reliance on space, and they understand the competitive advantage we derive from space. The need for vigilance has never been greater.

Experimentation

Space Situational Awareness (SSA) allows us to detect adversary actions and decipher their intent. Characterizing pre- and post-launch events combined with on-orbit assets gives leadership and operators time to assess options and respond appropriately to the environment. SSA also gives us the ability to distinguish between spacecraft malfunctions or failures; specifically, it gives us the ability to distinguish between hostile actions or naturally-occurring phenomena. In order to facilitate unity of effort and information sharing across our national security space enterprise, the DoD, the Office of the Director of National Intelligence, United States Strategic Command (USSTRATCOM), the National Reconnaissance Office and AFSPC established a Joint Interagency Combined Space Operations Center (JICSpOC) at Schriever Air Force Base, Colorado. The JICSpOC is focused on space defense, and is developing new space-system operational concepts, and tactics, techniques and procedures in support of both the DoD and Intelligence Community. Fusing the operations of our space systems and intelligence capabilities in real-time will enhance our ability to track, monitor, analyze and predict irresponsible and dangerous activity in space. This fusion is a first step towards ensuring the U.S., its allies and partners remain free to use space for civil, commercial and national security purposes.

The JICSpOC is needed to ensure the national security space enterprise meets and out-paces emerging and advanced space threats. This initiative continues to provide vital information and capabilities to national leadership, allies and partners, and joint warfighters. It provides the DoD and the Intelligence Community with a robust test and experimentation environment to better integrate our space operations in response to threats and improve unite of effort between diverse national security space communities. The JICSpOC serves to enhance the

nation's deterrent posture by demonstrating the United States is prepared to respond should an adversary attempt to threaten our space capabilities.

Joint Space Operations Center (JSpOC) Mission System (JMS)

Through the JSpOC Mission System (JMS), we are building a new open architecture, high performance computing environment, to give our operators a modern capability to integrate SSA data. JMS goes beyond the integration of metric and positional data to support predictive awareness. Ultimately, we need the capability for true battle management, and command and control of space forces.

Declaration of initial operational capability for JMS Increment 1 was completed in April 2013. Increment 2, when delivered, will provide, in conjunction with new and enhanced sensors, an exquisite situational awareness capability and an understanding of what is going on in the space domain. What's missing is an embedded capability to leverage this information. We are investigating options to accelerate such a capability to give the Commander of the Joint Functional Component Command for Space (JFCC-SPACE) and the Commander of U.S. Strategic Command the ability to act. The BMC2 capabilities from JICSpOC will work hand-in-hand with the completed elements of JMS and will provide Commander JFCC-SPACE the appropriate data integration and exploitation infrastructure and capabilities to make better use of the tremendous volume of available sensor data, allow improved integration of intelligence data, enable more dynamic and innovative employment of our systems, and provide a more complete, real-time and predictive picture of activity in the space domain. This enhanced operating picture will ensure safety and security in the space environment now and in the future.

Space Mission Force (SMF)

The Space Mission Force (SMF) is going to fundamentally change how we operate space mission systems; how we organize, train, and equip our space capabilities and how we present forces to the Commander of U.S. Strategic Command. It is a paradigm shift in how we conduct space operations within the context of a contested domain. The goal of the SMF is to present forces to USSTRATCOM in a unified fashion that increases the commander's readiness to respond to potential threats against our space capabilities.

The objective of the SMF is to advance the knowledge and skills of our space operators to better function within a contested space environment. The SMF construct allows half of our squadron's crew force to conduct operations while the other half is conducting advanced training, similar to the approach taken in other major weapon systems. Through the Space Training Transformation initiative, we will facilitate rapid unit training content updates and enable the most cost-effective use of Air Force resources while increasing tactical understanding of the space domain. The SMF means posturing forces to accomplish different objectives by training against threats they have not seen before so they will be ready if called to reduce or counter potential adversary actions. We have to change our mindset from one of focusing solely on providing capability to terrestrial forces to a warfighter mindset prepared to defend against an adversary's threat in space. To do that, we have to advance the skillsets of our space crews, which requires a continuous training effort to purposefully advance the skills our Airmen to operate in a contested environment.

Conclusion

For the past 25 years, this country has been in a perpetual state of conflict, and the Airmen of AFSPC have been deployed or waging war in place for the duration. I frequently look

around this command with amazement at what our Airmen accomplish on a daily basis. It is one of my top priorities, and in our Nation's interest, to take care of these Airmen and their families.

One of our highest priorities is assured access to space and we appreciate Congress' support of this national security imperative. Our launch industrial base has improved; we now have competition, which has the potential to drive down the cost of access to space. However, challenges still remain. We buy launch as a service, and even with the emergence of a second certified launch provider, we are one failure away from severe curtailment or loss of our access to space.

Assured access to space is fundamental to delivering space capabilities. We certainly understand the importance of quickly ending our use of a Russian-manufactured rocket engine. In accordance with the law, we will further develop our domestic launch industrial base, including manufacturing the engines in the United States, and I will most certainly do my part to keep pressure on all involved to make this happen.

I remain committed to sustaining the highest levels of mission assurance and ensuring our objective to safely and reliably launch national security payloads on a schedule determined by the needs of the NSS enterprise. This requires a collective responsibility to safeguard the health of our Nation's space industry, to expand the launch business to encourage new entrants into the market, and to end the use of foreign rocket propulsion systems.

We in AFSPC have a sacred obligation to deliver space and cyberspace effects to Airmen, Soldiers, Sailors, and Marines wherever they are deployed, all the time. Modern warfare is not possible without the effects space and cyberspace capabilities provide. We are no longer a military that fields the most ships, tanks, infantrymen or aircraft. We are a military that integrates and synchronizes combat capabilities from all domains to create decisive and

dominant effects. AFSPC executes missions in two operational domains to ensure capability across them all. We are counting on the 35,700 men and women of AFSPC to continue conducting world-class, game-changing space and cyberspace operations that enable national decision-making and joint operations...and they do this every single day. I thank the Committee for their support and look forward to our continued partnership to provide resilient, capable, and affordable space capabilities for the Joint Force and the Nation.

General John E. Hyten

Gen. John E. Hyten is Commander, Air Force Space Command, Peterson Air Force Base, Colorado. He is responsible for organizing, equipping, training and maintaining mission-ready space and cyberspace forces and capabilities for North American Aerospace Defense Command, U.S. Strategic Command and other combatant commands around the world. General Hyten oversees Air Force network operations; manages a global network of satellite command and control, communications, missile warning and space launch facilities; and is responsible for space system development and acquisition. The command comprises approximately 40,000 space and cyberspace professionals assigned to 134 locations worldwide. General Hyten also directs and coordinates the activities of the headquarters staff.

General Hyten attended Harvard University on an Air Force Reserve Officer Training Corps scholarship, graduated in 1981 with a bachelor's degree in engineering and applied sciences and was commissioned a second lieutenant. General Hyten's career includes assignments in a variety of space acquisition and operations positions. He served in senior engineering positions on both Air Force and Army anti-satellite weapon system programs.

The general's staff assignments include tours with the Air Force Secretariat, the Air Staff, the Joint Staff and the Commander's Action Group at Headquarters Air Force Space Command as Director. He served as mission director in Cheyenne Mountain and was the last active-duty commander of the 6th Space Operations Squadron at Offutt AFB, Nebraska. In 2006, he deployed to Southwest Asia as Director of Space Forces for operations Enduring Freedom and Iraqi Freedom. General Hyten commanded the 595th Space Group and the 50th Space Wing at Schriever AFB, Colo. Prior to assuming command of Air Force Space Command, he served as the Vice Commander, Air Force Space Command.

EDUCATION

1981 Bachelor's degree in engineering and applied sciences, Harvard University, Cambridge, Mass.
1985 Master of Business Administration degree, Auburn University, Montgomery, Ala.
1985 Distinguished graduate, Squadron Officer School, Maxwell AFB, Ala.
1994 Distinguished graduate, Air Command and Staff College, Maxwell AFB, Ala.
1999 National Defense Fellow, University of Illinois, Champaign, Ill.
2011 Senior Managers in Government Course, Harvard University, Cambridge, Mass

ASSIGNMENTS

1. November 1981 - December 1985, Configuration Management Officer and Chief, Configuration Management Division, Automated Systems Program Office, Gunter AFB, Ala.
2. December 1985 - July 1989, Chief, Software Development Branch; and Chief, Engineering and Acquisition Division, Space Defense Programs Office, Los Angeles AFB, Calif.
3. August 1989 - July 1990, Special Adviser to the U.S. Army, Kinetic Energy Anti-Satellite Program Office, U.S. Army Strategic Defense Command, Huntsville, Ala.
4. July 1990 - August 1991, Deputy for Engineering, Strategic Defense Initiatives Program Office, Los Angeles AFB, Calif.
5. August 1991 - May 1992, Executive Speechwriter and Systems Analyst, Assistant Secretary of the Air Force (Acquisition), the Pentagon, Washington, D.C.
6. May 1992 - July 1993, Program Element Monitor, Advanced Technology Programs, Assistant Secretary of the Air Force (Acquisition), the Pentagon, Washington, D.C.

7. July 1993 - June 1994, Student, Air Command and Staff College, Maxwell AFB, Ala.
8. July 1994 - June 1996, Mission Director, Space Operations Officer, and Chief, Command Center Training, U.S. Space Command, Cheyenne Mountain Air Force Station, Colo.
9. August 1996 - August 1998, Commander, 6th Space Operations Squadron, Offutt AFB, Neb.
10. August 1998 - June 1999, National Defense Fellow, University of Illinois, Champaign
11. June 1999 - June 2001, Operations Officer, and Chief, Space Branch, Defense and Space Operations Division, Deputy Director for Operations (Current Readiness and Capabilities), J3, Joint Staff, the Pentagon, Washington, D.C.
12. June 2001 - June 2003, Chief, Space Control Division, Directorate for Space Operations and Integration, Deputy Chief of Staff for Air and Space Operations, Headquarters U.S. Air Force, Washington, D.C.
13. June 2003 - July 2004, Director, Commander's Action Group, Headquarters Air Force Space Command, Peterson AFB, Colo.
14. July 2004 - April 2005, Commander, 595th Space Group, Schriever AFB, Colo.
15. April 2005 - May 2007, Commander, 50th Space Wing, Schriever AFB, Colo. (May 2006 - October 2006, Director of Space Forces, U.S. Central Command Air Forces, Southwest Asia)
16. May 2007- September 2009, Director of Requirements, Headquarters Air Force Space Command, Peterson AFB, Colo.
17. September 2009 - February 2010, Director, Cyber and Space Operations, Directorate of Operations. Deputy Chief of Staff for Operations, Plans and Requirements, Headquarters U.S. Air Force, Washington, D.C.
18. February 2010 - August 2010, Director, Space Acquisition, Office of the Under Secretary of the Air Force, the Pentagon, Washington, D.C.
19. September 2010 - May 2012, Director, Space Programs, Office of the Assistant Secretary of the Air Force for Acquisition, Washington, D.C.
20. May 2012 - Aug 2014, Vice Commander, Air Force Space Command, Peterson AFB, Colo.
21. Aug 2014 – present, Commander, Air Force Space Command, Peterson AFB, Colo.

SUMMARY OF JOINT ASSIGNMENTS
1. July 1994 - June 1996, Mission Director, Space Operations Officer, and Chief, Command Center Training, U.S. Space Command, Cheyenne Mountain Air Force Station, CO., as a major
2. June 1999 - June 2001, Operations Officer, and Chief, Space Branch, Defense and Space Operations Division, Deputy Director for Operations (Current Readiness and Capabilities), J3, Joint Staff, the Pentagon, Washington, D.C., as a lieutenant colonel

BADGES
Master Space Operations Badge
Master Cyberspace Operator Badge

MAJOR AWARDS AND DECORATIONS
Distinguished Service Medal
Legion of Merit with oak leaf cluster
Defense Meritorious Service Medal with two oak leaf clusters
Meritorious Service Medal with four oak leaf clusters
Air Force Commendation Medal Army Commendation Medal Joint Staff Achievement Medal Air Force Achievement Medal

OTHER ACHIEVEMENTS
1991 Recipient of the William Jump Award for Excellence within the Federal Government
1998 Recipient of a Laurels Award, Aviation Week and Space Technology Magazine
2009 Gen. Jerome F. O'Malley Distinguished Space Leadership Award

PUBLICATIONS
"A Sea of Peace or a Theater of War: Dealing with the Inevitable Conflict in Space," The Program in Arms Control, Disarmament, and International Security Occasional Paper, University of Illinois, 2000 "A Sea of Peace or a Theater of War," Air and Space Power Journal, Air University Press, 2002
"Moral and Ethical Decisions Regarding Space Warfare," with Dr. Robert Uy, Air and Space Power Journal, Air University Press, 2004

EFFECTIVE DATES OF PROMOTION
Second Lieutenant Aug. 23, 1981
First Lieutenant Aug. 23, 1983
Captain Aug. 23, 1985
Major May 1, 1993
Lieutenant Colonel Jan. 1, 1997
Colonel June 1, 2002
Brigadier General Oct. 1, 2007
Major General Nov. 10, 2010
Lieutenant General May 18, 2012
General Aug. 15, 2014

(Current as of August 2014)

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THE HOUSE ARMED SERVICES COMMITTEE

STATEMENT OF

DOUGLAS LOVERRO

DEPUTY ASSISTANT SECRETARY OF DEFENSE

(SPACE POLICY)

BEFORE THE

SUBCOMMITTEE ON STRATEGIC FORCES
HOUSE ARMED SERVICES COMMITTEE

ON

FISCAL YEAR 2017 NATIONAL DEFENSE AUTHORIZATION BUDGET REQUEST FOR
NATIONAL SECURITY SPACE ACTIVITIES

MARCH 15, 2016

Introduction

Chairman Rogers, Ranking Member Cooper, and Members of the Subcommittee—I am pleased to come before you today along with Gen Hyten, Mr. Weatherington, Lt Gen Buck, Mr. Cardillo, and Mr. Calvelli to discuss the Department of Defense's national security space program for 2017 and to report to you on the shared progress we have all made to extend confidence in our space forces and respond to the growing threats in that domain. My testimony today is a continuation of the dialogue that I began with this committee three years ago, and I am pleased to report that we have made substantial progress since then.

In the past, I've testified on the efforts that the Department has made to reorient its efforts in space to address the growing and aggressive threats we see from several nations around the globe. That effort culminated, in great measure, with the budget that the President submitted last year in which we substantially and specifically focused on initiating multiple activities throughout the space enterprise to counter those threats. FY 16 was the year in which we began to adjust the U.S. space posture to the realities of a future space environment that could be contested. In that environment, it is our intent to posture U.S. space forces to deter attacks in space and, if deterrence fails, to continually assure warfighting space services are available for our terrestrial warfighters. With your help, that budget passed and that work has begun. Our FY 17 budget continues those gains, extending similar investments throughout the rest of the enterprise as well as initiating additional efforts to better prepare us for that eventual reality.

In our discussion today I know that you will want to hear more about the "nuts and bolts" of the FY 17 submission, and I am happy to join my fellow witnesses in that discussion. But before we enter into that detailed line-by-line assessment, I'd like to spend a few moments going beyond the specifics of budgeting and focus instead on the objectives and intent of our strategy. For it is only against that strategy that we can truly judge the adequacy and efficacy of our budget.

The Importance of Space

To begin, let me assure this committee that the fundamentals of our intent have not changed. Space remains, and will remain, vital to U.S. national security. The threats that we have recognized and that Director of National Intelligence Clapper has testified to in detail, do not dissuade us from our resolve to leverage space for U.S advantage. Space services are inextricably woven throughout the fabric of our defense and national security infrastructure, and we do not intend to yield them. Space capabilities enable continuous U.S. presence around the globe to deter conflict as well as to enable swift and sure responses to humanitarian crises, the latest terrorist threats, and conflict between states. Space enables the United States to monitor world activities in real time, and to respond where and when we are needed.

Civil and commercial space capabilities add to this national security core and are part of our civilian critical infrastructure, creating opportunities to conduct business seamlessly across the planet, to guide goods and services to their final destinations, and to examine changes in our natural environment on a continual basis. These advantages go beyond purely U.S. national security interests and remind us that while we will defend those U.S. interests, we remain fully committed to assuring the peaceful use of space by all nations.

For this reason, as Gen Hyten stated last year, the United States has no desire to see a war extend into space. We don't think that is in our interests, the interests of our allies, nor in the interests of would-be adversaries. But let me be clear about our intent—we will be ready. We are making changes in our systems, our tactics, our culture, and our people to assure that if that eventuality arises, we will be able to defend U.S. and allied interests in space. We want to make sure that it is clearly recognized that no matter the threat, no matter the expected level of effort, attacks on U.S. space services are strategically ill-advised and militarily ineffective. By assuring this is the case and by posturing ourselves in such a way that space cannot be taken away, it is our belief that we will deter attacks on space in the first place and, by extension, deter aggression overall. Today our adversaries perceive that space is a weak-link in our deterrence calculus. Our strategy is to strengthen

that link, to assure it never breaks, and to disabuse our adversaries of the idea that our space capabilities make tempting targets.

I'd like to spend a few minutes describing this space deterrence calculus, how it works and why it might be different from deterrence equations of the past. Then I will explain how we achieve it.

Space and Deterrence

During the cold war, the idea of deterrence centered on concepts of assured retaliation and imposition of overwhelming cost—so called Mutually Assured Destruction. Space forces were vital during that era to execute that deterrent posture. Space forces supported two primary objectives: first, to provide strategic indications and warning and confirmation of an attack; and second, to provide the means to command and control a U.S. response. This connection between space forces and effective nuclear reprisal meant that attacks on space were viewed as a prelude to nuclear conflict. As such, during the cold war, attacks on space systems themselves were deterred by their linkage to nuclear warfighting.

Recognizing this fact, U.S. space forces were developed to operate in that environment. We designed them to be nuclear hardened, to have electromagnetic pulse-hardened and survivable back-up ground infrastructure, and to be operated in such a manner that they could function before, during, and after a nuclear conflict. We retain that capability today because, while it may be true that newer and less violent threats are our most current focus, we can never abandon the need to assure space's role in our nuclear posture.

Space's role in modern conventional deterrence is far more nuanced than it is for nuclear deterrence. Conventional deterrence relies on an adversary's perception of the ability and likelihood of a U.S. or coalition response to provocation. Today, there is a perception that by denying our access to space services, an aggressor can blunt a U.S. response—to cause it to be less certain, less timely, and less overwhelming. This perception leads to a destabilizing reality—by attacking, or threatening, U.S. conventional space capabilities adversaries believe they may deter U.S. entry into a conflict. In this new conventional

reality, space forces are seen as the chink in the conventional armor of the United States—the place to gain an asymmetric advantage and reduce the likelihood of a U.S. response.

Potential adversaries also recognize that because we use space capabilities to project power globally, to multiply the speed, effectiveness, and impact of a conventional response, early attacks on space have a doubly beneficial impact—even if they do not deter a response, they make it less effective.

This condition leads to a seemingly paradoxical situation for space forces in which attacks on space capabilities are driven by their linkage to conventional war; the opposite of where we found ourselves strategically for nuclear war. In this topsy-turvy state, attacks on space forces may even become the opening gambit of an anti-access/area-denial strategy in a regional conflict wherein an adversary seeks to forestall or preclude a U.S. military response. Chinese military strategists began writing about the targeting of space assets as a "tempting and most irresistible choice" in the late 1990s, and the People's Liberation Army has been pursuing the necessary capabilities ever since.

Therefore, we must remove the likelihood that attacks in space will succeed. Strangely enough, there are those who believe that we cannot do this. That we cannot assure space systems in the face of conventional attack in the same way we assured them in the face of nuclear attack. That somehow the threat from co-orbital microsatellites or direct ascent conventional missiles is harder to defend against than the threat of a directly launched nuclear weapon. That conclusion would be untrue. Certainly defense against these newer kinds of attacks will require different techniques; but be assured, as a nation, we can and will assure our space systems against those threats.

Space Mission Assurance

During our strategic portfolio review of 2014 we developed the concept of Assured Space Operations—the notion that space forces needed to be as dependable as the forces that depend on them, regardless of threat. For nuclear and strategically-linked space forces, this meant as high a level of assurance as we maintained during the cold war. For more

tactically-linked space services, this meant that space forces needed to be assured through every phase of conventional conflict.

In 2015 we developed the mechanism to execute those assurance requirements, creating the DoD Space Mission Assurance Framework. It included three assurance pathways: reconstitution, defensive operations, and resilience. We are in the process of promulgating DoD policy that makes it mandatory to include some or all of these types of mission assurance pathways in all new space systems. While the specific combinations we will choose are mission and architecture dependent, one or all must be included in any operational architecture in order to meet the precepts of Assured Space Operations.

We're hard at work across the DoD space enterprise to determine how we best execute these concepts, both operationally and architecturally. On the operational side, U.S. Strategic Command, Air Force Space Command, and the National Reconnaissance Office are actively working to understand the doctrinal and command and control aspects of this new posture through initiatives such as the Joint Interagency and Combined Space Operation Center (JICSpOC) experiments and the Joint Space Doctrine and Tactics Forum (JSDTF)

On the architectural side, we are reexamining completed analyses of alternatives, and beginning new ones, with this new mission assurance mindset at the front and center. As we engage in that process, we recognize that assurance efforts will not create the deterrence posture we seek unless they can be communicated to potential adversaries. In order to deter space attack, would-be attackers need to understand or at least suspect that their attacks will likely be unsuccessful. Recognizing that all assurance efforts will not be openly broadcast, we are working to strike the balance between those assurance efforts that are understandable and measurable by the adversary, and those that must remain more ambiguous. As we've worked through that calculus we arrive at the conclusion that of the three pathways we've outlined—reconstitution, defensive operations, and resilience—resilience is the best path for both understandable assurance and robust assurance. It's also the area where we can best offset the advantages that adversaries seek to exploit with their offensive space control ambitions.

An Offset Strategy for Space

As potential adversaries attempt to deny U.S. warfighters the advantages that space confers, the United States must find ways to offset the relatively cheap and technologically obtainable methods that adversaries have begun to employ. An advanced U.S. satellite might cost upwards of $1 billion; missiles that could destroy such a satellite cost a few percent of that sum; co-orbital microsatellites cost even less; and lasers that might blind or damage satellites have an unlimited magazine with almost zero cost per shot. The same can be said for a cyber attack. While many advocates have called for the United States to move to small, reconstitute-able satellites as a reaction to these threats, it's far from clear that this strategy could ever serve to offset the cost advantage that these methods employ, nor is it clear that a single, monolithic strategy can ever defeat an advancing and evolving threat. Plus, such a reaction limits the immense advantages the United States garners during lower intensity conflicts from our exquisite space capabilities.

Rather, a space offset strategy must employ a diverse set of resilience measures that complicate the technical, political, and force structure calculus of our adversaries, by arraying a complex set of responses, with few overlapping vulnerabilities and a combination of known and ambiguous elements. To do this within our expected budget limitation, the U.S. response is clear—we must leverage our two natural and sustained space advantages: the U.S. commercial/entrepreneurial space sector, and our ability to form coalitions with our space-faring allies.

Space Security and Commercial/Entrepreneurial Space

The technologies and opportunities of greatest significance for national security space today are being paced by advances in the commercial space sector. The situation is profoundly different from the one confronted by the Defense Department in the early cold war era. In that era, the U.S. Defense Department led the way in national security space, with little interest or need to access commercial space services. Today, the DoD is already significantly dependent upon commercial satellite communication (SatCom) capabilities to meet its worldwide communication needs; the same is true for remote sensing.

On the communication front, the future holds even greater promise of new and ubiquitous high throughput systems from IntelSat to ViaSat, among others, as well as multiple entrepreneurial startups, such as from One Web and Space Explorations Technologies (SpaceX). Thanks to the $26 million supported in the FY 2016 National Defense Authorization Act, the Air Force is planning to fund new business arrangements, so called Commercial SatCom pathfinders, to determine ways to better access these new commercial capabilities. In the President's 2017 budget we have included an additional $121 million over the five year defense plan to continue that work. These funds will not only create new business arrangements that will save money; they are intended to provide new kinds of access to commercial SatCom capabilities to increase resiliency and to complicate any adversary attack. It's one thing to have to eliminate the communication capabilities of a few centrally controlled Wideband Global SatCom (WGS) satellites; it's quite another to have to deny communications from dozens of commercial satellites all built by different companies and all operated independently. And if the newer entrepreneurial firms are successful, these numbers rise to hundreds or even thousands of satellites in completely different orbits. The key question for DoD is how best to leverage these advances as part of our resilience efforts.

A similar dynamic is playing out in the commercial remote sensing field. Many operators, from SkyBox, to Planet Labs, to Urthecast, to BlackSky Global, are adding to the already substantial capabilities of DigitalGlobe, flying dozens of satellites with plans to add hundreds more. Our job is not to figure out how to buy similar systems, but rather how best to access those launched by industry; how to work with them to assure they can serve us during peace and during conflict, and most importantly, how to make sure they remain onshore as U.S firms. It is for that reason, among others, that the administration two years ago relaxed commercial remote sensing restrictions. By lowering the regulatory barriers to entry, we can encourage greater entrepreneurial investment here at home, and add to the already large and growing stable of resilient space applications now budding across the nation.

While SatCom and remote sensing are the most notable areas of commercial leverage, they are far from alone. The United States is experiencing rapid growth in almost all space services that were previously the provenance of only government, from ground entry points, satellite telemetry and control, space situational awareness, weather, and of course space launch. Commercial satellite servicing is also on the way. The robust and burgeoning commercial space sector provides unmatched opportunity for the United States to augment and supplement traditional government-owned capabilities with U.S commercial capabilities, with significant increases in resilience and mission capability, all while lowering overall cost.

Our job in the DoD is to figure out how best to access these capabilities and to work with the Congress and other sectors of the executive branch to develop the right regulatory structure that encourages greater risk taking, without creating greater risks. We believe the time is right to examine the role of a civil agency, such as the Federal Aviation Administration, to begin to explore how to monitor and regulate this exponentially expanding population of commercial space systems to best position the United States to maintain leadership in this field.

Space Security and International Engagement

While the United States may be the world's preeminent space power, we are not in this alone—many of our allies are in space with us. Our 2014 Portfolio Review highlighted that the strategic pursuit of partnerships with allied nations can simultaneously reduce the need for direct U.S. government investment, increase the complexity of the target set our adversaries must engage, diversify the means for us to support space missions, and create political hurdles for any adversary who might want to try to isolate the United States. Just as we need to leverage commercial space capabilities, so too do we need to capitalize on our allies' investments in space services.

This year, we added New Zealand to our previously announced Combined Space Operations (CSpO) initiative, creating a true five-eye coalition approach to space operations. CSpO provides the venue to coordinate our space activities, share insights and

knowledge of the space environment, and to plan and exercise our space forces together. This effort is the start of creating a true coalition approach to space operations. By increasing awareness of shared threats and our plans to deal with them, our common understanding has highlighted the importance of space to senior leaders across the globe. While CSpO is still a nascent effort, the Department is committed to achieving the desired end state with our partners. Moving forward, we recognize the importance of bringing other like-minded allies and partners into this initiative.

The CSpO forum is only but one of an extensive array of bilateral arrangements and initiatives. The DoD has, as of today, signed a total of 63 space situational awareness sharing agreements with commercial partners, multi-lateral organizations, and other countries. Not only have we been working very closely with our four CSpO partners, but with many other allies and partners, including Japan, France, Germany, the European Union (EU), and others to find areas where we can cooperate in both space operations and space service provisions. Each of these nations maintains multiple space capabilities of their own, and by planning and operating them together, we garner significant additional mission capability and immeasurable resilience capacity.

For example, in the remote sensing realm, each of these nations fly their own indigenous electro-optical and radar imaging capabilities, each fundamentally different in capability, each with different vulnerability characteristics, and each presenting a different political dynamic to would-be adversaries. The National Geospatial Intelligence Agency (NGA), under the leadership of Director Cardillo, is working to integrate all these capabilities so that U.S. warfighters can rely on not just U.S. Government owned, or U.S commercial imagers, but on the entire range of imaging capabilities from our allies. Today, that includes nearly 200 satellites and likely 20 ground infrastructures. By 2020, it will likely rise to over 600 satellites. Using this lever to increase assurance of U.S. imaging capacity presents an extremely complex problem to our adversaries, with little increase in our own costs. This is resilience upon which we can all agree.

On the position, navigation, and timing (PNT) front we are working similar initiatives. With the State Department, the administration is working with the European Union to gain

access to their own encrypted PNT service known as the Publically Regulated Service (PRS) from the Galileo satellite system. We're working with Japan to investigate how best to leverage their home-grown regional PNT system called the Quasi-Zenith Satellite System (QZSS); and we're examining the efficacy of providing our warfighters with enhanced military-code user equipment that can access signals from all these systems. Such a strategy would deny any warfighting benefit from an attack on the Global Positioning System (GPS), because a U.S. warfighter and our allies would still be able to navigate with certainty.

We're also working with allies to extend the benefits of the Mobile User Objective System (MUOS) to meet their needs, and with NATO to assure our European allies the access to protected communications such as the Advanced Extremely High Frequency (AEHF) system, to operate through the intensifying jamming threat in Europe.

From remote sensing to PNT, to space situational awareness, to satellite communications, and other services beyond, our allies will play an ever increasing role in how the United States assures space for ourselves and for them. Of course this is no different from the same dynamic we see on land, at sea, and in the air, from combined naval exercises in the Pacific, to combined land exercises in Europe. Alliances have always been critical to the U.S. deterrence posture, and space is no different—we're just not used to it.

Finally, an additional benefit of expanded international and commercial cooperation is the potential for U.S. space exports to allies and partners. To enable this possibility, DoD will work with the Department of State and Department of Commerce to support approval of appropriate export control legislation and space-related technology sharing, and encourage the appropriate U.S. space exports to our allies and partners to enhance their capabilities. This in turn expands U.S. trade with allies and enhances U.S.-allied combined warfighting capabilities—and strengthens the deterrent posture we desire.

Closing

Chairman Rogers, Ranking Member Cooper, and Members of the Subcommittee —I've spoken primarily today not about budget but of strategy; of how we intend to address the

threats we see arrayed before us in the coming years and how we intend to do so within the means we can afford. Clearly there are other efforts in the budget that also enhance U.S. space security and deterrence with direct government investment—from designing the next block of GPS satellites, to the follow-on to the Space Based Infrared Satellite (SBIRS) and AEHF systems. I know that we will review these over the course of this hearing.

But just as important as these direct investments is the articulation and realization of an offset strategy for space that deters conflict on earth and in space. Our adversaries are determined to take space away from us to deter U.S. action. We are determined to assure that this will not be the case. We believe that with the combination of direct DoD investment and incorporation of robust and growing commercial and coalition capabilities, we can meet this challenge. More than dollars, that will require new thinking. It will require outreach, new ways of viewing the problem, and a change to our long held view that we can go it alone in space. We can't and we don't want to. Our challenge therefore is to determine not just what to invest in, but how to change policies and strategies to incorporate these new ways of solving the space assurance problem.

I thank you for the opportunity to provide these updates on the Department's space policies and programs. My colleagues and I look forward to working closely with Congress on implementing this new approach to space and I stand ready to answer your questions.

Douglas L. Loverro
Deputy Assistant Secretary of Defense for Space Policy

Mr. Douglas L. Loverro, a member of the Senior Executive Service, is the Deputy Assistant Secretary of Defense for Space Policy. In this role, he is responsible for establishing policy and guidance to assure United States and allied warfighters the benefits of Space capabilities and to help guide the Department's strategy for addressing space-related issues. He also leads Departmental activities in international space cooperation.

Mr. Loverro most recently served as the Executive Director for Air Force Space Command's Space and Missile Systems Center where he also served as the Air Force's Deputy Program Executive Officer (PEO) for Space. In that capacity, he was responsible to the commander and PEO for the development, deployment, and sustainment of all Department of Air Force space systems and was a key spokesman for addressing the growing importance of space systems and the steps needed to assure them for the future. He has been involved in the planning and acquisition of Department of Defense (DoD) and Sace Intelligence systems for over twenty years, both in and out of uniform.

Mr. Loverro is credited with a wide-ranging list of accomplishments in aerospace development including the invention of the supersonic chemical oxygen-iodine laser, the initiation of the DoD's Global Broadcast Service, establishing the foundation for all Global Positioning System modernization, and leading the push for greater use of commercial manufacturing and capabilities for future DoD space and launch systems. He retired from active duty in February 2006 upon selection as a member of the Defense Intelligence Senior Executive Service. He assumed his current role in March 2013.

Mr. Loverro holds a B.S. in Chemistry from the United States Air Force Academy, an M.S. in Physics from the University of New Mexico, an M.S. in Political Science from Auburn University, and an M.B.A. from the University of West Florida. He was the top graduate from his class in the Industrial College of the Armed Forces and is a graduate of the JFK School of Government Senior Executives in National and International Security Program.

Mr. Loverro is married to Stephanie Loverro and they have two children, Adam and Kari. He is an avid triathlete and is in competition with his daughter, who is winning.

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SUBCOMMITTEE ON STRATEGIC FORCES
HOUSE ARMED SERVICES COMMITTEE
UNITED STATES HOUSE OF REPRESENTATIVES

STATEMENT OF

MR. DYKE WEATHERINGTON
PRINCIPAL DIRECTOR
FOR SPACE, STRATEGIC, AND INTELLIGENCE SYSTEMS

BEFORE THE HOUSE COMMITTEE
ON ARMED SERVICES
SUBCOMMITTEE ON STRATEGIC FORCES

MARCH 15, 2016

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Introduction

Chairman Rogers, Ranking Member Cooper, and Members of the Subcommittee, I am pleased to join General Hyten, Lt. General Buck, Ms. Sapp, Mr. Cardillo and Mr. Loverro to testify on Department of Defense space programs.

In my testimony I want to highlight recent activity of the Department that will continue to allow us to operate in an increasingly congested, competitive and contested space domain.

During 2015 the DoD launched eight national security space payloads– including tactical and strategic communications, and navigation, position and timing satellites – capabilities benefiting both military and civilian users. Our engagement with allies to build America's space partnerships and our continuing focus on Better Buying Power, sound systems engineering and the hard work of our acquisition professionals are resulting in noteworthy savings to the US taxpayer. Examples include over $1 billion savings in the Space Based Infrared System (SBIRS) program and, in space launch, our continuing benefit from the over $4 billion savings from the Evolved Expendable Launch Vehicle (EELV) program Block Buy. This year, we also qualified a new launch provider to increase competition, reduce costs, and preserve American assure access to space in the future. Emergence of this new provider is allowing the Department to compete the launch service contract for the Global Positioning System (GPS) III-2 satellite, the first competition held for launch of a National Security Space (NSS) mission since 2006. These acquisition successes are encouraging but we face increasing threats that require us to continue evolving our space architectures and acquisition strategies.

The space domain has changed significantly in fifty years. It has evolved from a sparsely populated, essentially uncontested destination to a crowed domain where potential adversaries seek to counter our capabilities.. The environment has seen many types of activity proliferate: the number of spacefaring nations has increased dramatically since Sputnik; users of space systems and products have multiplied; space capabilities and activities have become enmeshed in the security and economic affairs of many nations. For the United States, space has become pervasive in all aspects of our

thinking about military operations and warfare. Our asymmetric advantage in space also creates asymmetric vulnerabilities. Our potential adversaries recognize our dependence on space and continue to develop and field a range of capabilities and means to deny our ability to use space.

The Threat

Even as our dependence on space capabilities continues to increase, and although we maintain a substantial asymmetric advantage due to those capabilities, the rapid evolution and expansion of threats to our space capabilities in every orbit regime has highlighted the converse: an asymmetric disadvantage due to the inherent susceptibilities and increasing vulnerabilities of these systems.

We risk encountering a potential strategic imbalance in which adversaries are increasingly able to use space to support military operations, and also threaten our ability to sustain use of our space capabilities. Meanwhile our abilities have lagged to protect our own use of space and operate through the effects of adversary threats. Any adversary would almost certainly trade its own ability to utilize space if in return it could deny U.S. use of space to support military and intelligence operations.

I would like to amplify details about a few specific programs that offer insight into how we are balancing our acquisition approaches with the need to counter emerging threats as we look to the future.

Space Based Infrared System (SBIRS)

In July 2015, the third Geosynchronous Earth Orbit (GEO) satellite entered storage. The fourth GEO satellite is in integration and test and remains on track for a July 2016 launch. SBIRS GEO satellites 5 and 6 are progressing according to plan and are within cost and schedule. SBIRS continues to utilize Space Modernization Initiative (SMI) investments to improve affordability, reduce risk and enhance the current program of record to remain effective in a strategic environment. SBIRS SMI continues to invest in efforts that explore the trade space for future acquisition decisions through

studies and investments that explore future technology alternatives and architectures. As part of their resiliency efforts, the SBIRS program is transitioning to use of commercial buses and we are exploring alternate orbits. In February, Air Force Space Command established a team to evaluate how SBIRS will transition to the future space enterprise and improve its resiliency posture. This team will conclude its evaluation with a final deliverable in late summer which is expected to inform future acquisition investment decisions.

SBIRS ground development, GEO starer data availability and progress toward full integration into ground operations remain on-track. Current real-time missile warning is accomplished using only scanner sensor data from SBIRS GEO satellites and Highly Elliptical Orbit (HEO) payloads. The GEO starer sensor is manually taskable today and starer sensor wideband data from SBIRS GEO satellites has been available to a limited set of users since 2013 in support of the Battlespace Awareness mission area. In November 2016, Block 10.3 Missile Warning (MW) messages will include data from both scanner and starer sensors. Block 10.3 will provide performance equal to, and in many cases significantly better than, the current operational system (Increment 1) and provide starer manual cueing for track burn out. GEO starer data will be included in operational MW messages after Program Executive Officer certification of the ground system in 2016. Block 20 ground software (delivery in 2018) will increase performance beyond the current Increment 1 system and will include automated tipping and cueing. Operational Acceptance of the Initial Capability (Increment 2) Ground Architecture is projected for November 2016.

Evolved Expendable Launch Vehicle (EELV)

Our assured access to space provides national security decision-makers with unfettered global access and unprecedented advantages in national decision-making, military operations, and homeland security. Maintaining the benefits afforded to the United States by space is central to our national security, and enabling our space operations requires we have access to efficient and reliable space launch capabilities,

that are robust, responsive and resilient. The DoD's focus on sound and disciplined systems engineering practices, what we call our Mission Assurance Process, emerged from very hard lessons learned from a string of costly failures in the late 1990's.

Over the past 17 years, this National Security Space (NSS) Mission Assurance Process has proven to be exceptionally effective with an incredible record of 92 successful operational EELV missions since 2002 and 118 National Security missions since 1999. We champion mission assurance because the cost of a single launch failure, especially one with a multibillion dollar satellite on board, can very quickly overwhelm any savings achieved by overly aggressive cost-cutting acquisition strategies. This is why we consider certification of new entrants, and mission assurance for all launch service providers, to be essential elements of our Assured Access to Space. As we employ the certification process with new entrants to the EELV program, we continue this focus in cooperation with each of the prospective EELV new entrants. Our rigorous multi-step certification process ensures all new launch service providers meet the existing high NSS standards for design and operational reliability. We will continue to learn and evolve this process as new entrants are certified for the EELV program.

The last year has seen some major strides towards the Department's goal of ensuring the Nation has two or more commercially viable launch service providers that utilize domestically designed and manufactured propulsion systems, which are capable of meeting all the Department's space lift requirements. To this end, the Department has awarded almost $500M in development agreements to industry. These agreements focus on technology development and maturation in areas that are critical to the advancement of new propulsion capabilities, including both hydrocarbon based liquid rocket engines and solid rocket motors. Most recently four other transaction agreements (OTA) were awarded to both current and prospective launch service providers and rocket engine manufactures. The prototype work to be accomplished under these OTAs will directly focus on engine/motor development activities. This will allow a seamless transition into the new launch service capability development activities that the Department plans to fund in FY 17 and beyond.

The Air Force's long-term strategy continues to be to introduce competition into the EELV program as soon as possible by providing the opportunity for multiple launch providers to successfully complete the New Entrant Certification process through the joint development of New Entrant Certification Plans. The Air Force works cooperatively with all potential new providers to confirm their understanding of the certification process and its requirements while ensuring they meet the stringent mission assurance standards necessary to launch our Nation's national security payloads.

Use of Russian Engines (RD-180)

Section 1608 of the 2015 National Defense Authorization Act (NDAA) restricts the use of the RD-180 rocket engine. Just as the Department complied with Congressional direction to incentivize industry to adopt the RD-180 in the 1990s, we are now taking steps to eliminate the use of Russian engines while maintaining assured access to space. As was testified to last year, the Department continues to believe that authorization for use of 18 RD-180 engines will be sufficient to maintain a competitive environment during the transition period, FY 18-22, to new and improved launch service capabilities.

I want to emphasize the Department is committed to transitioning off of the RD-180 as quickly as possible while minimizing impacts to national security. As we continue to work with Congress to eliminate our utilization of the RD-180 rocket engine, the Department firmly believes the best path to end the use of the RD-180 engine for launch of NSS satellites is through the use of public private partnerships, with industry, that result in new and improved launch service capabilities. As the Department begins, in FY 17, with authorization and appropriation by Congress, to work with industry to develop a new and improved domestically-powered launch capability, the Department would like to make that transition as efficient and affordable as possible. The ultimate goal remains for the Department to have two or more commercially-viable launch service providers capable of launching the entire NSS manifest using domestically produced propulsion systems.

In order to transition from the RD-180 and ensure the Department has at least two viable domestic launch service providers for assured access to space as quickly as possible, we need to transition to launch capability development in FY 17. The Department would greatly appreciate the committee's support for our planned launch service acquisition activities.

Global Positioning System (GPS)

GPS is the premier provider of worldwide Position, Navigation and Timing (PNT) information for both civilian and military users. The Air Force launched three GPS IIF satellites in 2015 and completed the IIF launch campaign successfully with the launch of the 12th and final IIF vehicle in February 2016. This provides 19 capable military code (M-Code) vehicles on orbit. During 2014, GPS Block II Electronic Protection reached Initial Operating Capability. This milestone provides the following Selective Availability Anti-Spoofing Module (SAASM) operations: Special Navigation, Over The Air Distribution and Over The Air Rekey, increasing resiliency and our ability to operate in increasingly hostile electronic environments.

The initial GPS space segment design was inherently resilient calling for 24 satellites in 6 separate planes. This provides 5-10 satellites in view at any given point on the earth when only four are required. We have enhanced that design flying 31 satellites now and we have in excess of 7 spares on orbit. The next generation satellite technology (GPS III) currently under development will provide approximately three times more military signal power providing a user with increased resilience in a jammed environment.

While GPS is one of our most resilient systems, the DoD is exploring capabilities that complement those and enhance future PNT resilience. Among these are chip-scale atomic clocks, tightly coupled inertial and GPS navigation subsystems, jam-resistant GPS receive antennas, and terrestrial PNT reference systems that are separate from GPS.

Weather Satellite Follow-On (WSF)

In 2013, the Department completed a space based environmental monitoring analysis of alternatives. The analysis concluded that environmental monitoring sensors operated by civilian agencies and international partners could provide the data required to satisfy eight of eleven mission-critical weather capabilities. As directed by the Joint Requirements Oversight Council, the Air Force is developing materiel solutions for the remaining three capabilities—those that cannot be satisfied by civilian agencies or allies: ocean surface vector winds, tropical cyclone intensity, and energetic charged particles. The Weather System Follow-on, or WSF, is the acquisition program that will provide these materiel solutions.

The WSF Objective System is planned as a single satellite constellation to measure ocean surface vector winds and tropical cyclone intensity. The WSF program will also develop energetic charged particle sensors that will be hosted on multiple DoD satellites. The Air Force began investing candidate WSF technologies in 2012 and plans to culminate their research effort with the launch of a demonstration payload, the Compact Ocean Wind Vector Radiometer, or COWVR, as an Operationally Responsive Space Office mission in 2017. COWVR was developed by NASA's Jet Propulsion Laboratory for the Air Force and its projected Size, Weight, and Power (SWAP) is a reduction of up to 50% and requires a smaller satellite bus and launch vehicle. If successful, this size reduction could allow the potential for a distributed network of small satellites, leading to increased resiliency. We expect the Air Force to bring forward an acquisition decision for the WSF Objective System this year.

Conclusion

The rise of foreign capability is jeopardizing our technological superiority. The Defense Department has to balance among many competing requirements and the President's Budget will, as it always has, reflect the best balance of force structure, readiness, and modernization available. I look forward to this committee's continued

support as the DoD uses the available resources as efficiently and effectively as possible to deliver capability to our warfighters.

Dyke D. Weatherington
Principal Director, Space, Strategic and Intelligence Systems

Mr. Dyke Weatherington is the Principal Director, Space, Strategic and Intelligence Systems (SSI), Office of the Under Secretary of Defense for Acquisition, Technology and Logistics (OUSD (AT&L)), Pentagon, Washington, D.C. He is responsible for acquisition shaping and oversight of space, strategic manned and unmanned aircraft, intelligence programs and treaty compliance executed by the DoD.

Mr. Weatherington's prior duties included Deputy Director, Intelligence, Surveillance and Reconnaissance in the SSI. His IC portfolio includes major system acquisition programs of the National Reconnaissance Office (NRO), National Geo-Spatial Agency (NGA), National Security Agency (NSA), and Defense Intelligence Agency (DIA). His DoD portfolio included Global Hawk, Triton NATO Alliance Ground Surveillance, Long Range Strike – Bomber and B-2, weapons systems. He serves as the SSI Senior Acquisition Officer and the primary liaison between Joint Staff, Services, Agencies, and Congress, facilitating actions to achieve cost, schedule, and performance goals and advising the Milestone Decision Authority on space, strategic, and intelligence program acquisition decisions. Mr. Weatherington was also the functional lead for the Deputy Secretary of Defense directed Unmanned Aircraft Systems Task Force that serves as a forum for the Military Departments to collaborate on UAS initiatives and resolve issues. He also serves as Chairman of the multi-agency UAS Executive Committee Senior Steering Group that addresses UAS access to the National Airspace System for the DoD, Federal Aviation Administration, Department of Homeland Security and National Aeronautics and Space Administration.

Prior to his assignment to SSI, Mr Weatherington was the Deputy Director, Unmanned Warfare and ISR, Strategic & Tactical Systems.

Mr. Weatherington holds a Bachelor of Science degree in engineering mechanics from the United States Air Force Academy (1981) and a Master of Arts in National Securities Studies from California State University (1993). He is also a graduate of the Air Force Air Command and Staff College and the Defense Systems Management College. He has been awarded numerous OSD and Air Force decorations including the Airman's Medal and OUSD Exceptional Civilian Service Award.

HOUSE COMMITTEE ON ARMED SERVICES

SUBCOMMITTEE ON STRATEGIC FORCES

STATEMENT OF

LIEUTENANT GENERAL DAVID J BUCK

COMMANDER

JOINT FUNCTIONAL COMPONENT COMMAND FOR SPACE

BEFORE THE HOUSE ARMED SERVICES SUBCOMMITTEE ON STRATEGIC FORCES ON FISCAL YEAR 2017 NATIONAL DEFENSE AUTHORIZATION BUDGET REQUEST FOR SPACE PROGRAMS

15 MARCH 2016

HOUSE COMMITTEE ON ARMED SERVICES

SUBCOMMITTEE ON STRATEGIC FORCES

Introduction

Chairman Rogers, Representative Cooper, members of the Subcommittee, thank you for your time this afternoon. More importantly, thank you for your steadfast support for our men and women in uniform and this Nation. I'm honored to appear before you, side-by-side with my esteemed colleagues, as the Commander of United States Strategic Command's Joint Functional Component Command for Space, or simply JFCC Space.

As Commander JFCC Space, I'm privileged to lead a world-class team of space professionals from across the Services and with strong participation from our commercial and Allied partners. The command is laser-focused on delivering combat effects for the current fight while simultaneously preparing for tomorrow's. A key tenet is domain superiority and the ability to provide unfettered access in, through and from space for the international community and ensuring that access exists for all nations.

And like every other domain . . . be it air, land, sea or cyberspace . . . freedom of action is foundational. That said freedom of action in the space domain cuts a pretty wide swath. In order to maintain our operational advantage we must continue to normalize the space domain in areas like information dominance, mission resilience and the ability to protect and defend through robust battle management command and control (BMC2). Building strong connective tissue across the Department of Defense (DOD), with the Intelligence Community (IC), the Interagency (IA) and with our commercial and Allied partners is foundational to these efforts.

As this Committee is well aware, space underpins our Nation's way of life in peacetime and provides critical warfighting capabilities during conflict. It's no surprise that potential adversaries have taken notice and are working to counter our operational advantages in space.

Since testimony at this Committee last year, potential threats to our freedom of action in space continue to evolve. Our ability to deliver space effects is challenged by the unprecedented

development of counter-space programs . . . resources invested and systems designed to deny or degrade our freedom of action. The implication, of course, is that we can no longer take for granted the strategic, operational and tactical advantages we've come to depend on from space. From a warfighting perspective, the consequences are far reaching since an adversary can impose multi-domain impacts by denying or degrading space effects. Clearly, we don't ever want to fight a fight that extends to space, but we must be prepared. We must be prepared to defend ourselves and, if necessary, fight through a degraded space environment.

I've been in the space business awhile now and these are easily the most dynamic, complex and exciting times I've experienced. That said, I'm optimistic about the future. Through United States Strategic Command and with the help of this Committee, our Sister Services, the IC, IA, and commercial and Allied partners, there is a renewed emphasis on space. We will leverage innovation, experimentation, partnership and technology to meet current and emerging challenges to set the global standard for peaceful use of space.

I again thank you for the opportunity to offer my perspective. I look forward to continuing to work with you and your staffs to advance and protect our Nation's space capabilities.

Space Domain

Space is not a boutique domain or the exclusive purview of a few space-faring nations; rather, space is a common operating environment for approximately 60 nations, plus various governmental, commercial and academic organizations . . . and home to some 1,300 active satellites. In fact, a new satellite is launched almost every week. Unfortunately, not all space-faring nations view space as a peaceful domain – we have witnessed intent and ability to conduct hostile operations in this arena. Space has evolved like every other operating domain and is contested, degraded and operationally-limited (CDO) and it's imperative that we adapt our Tactics/Techniques/Procedures (TTPs), systems and cultures to enable us to fight through a

degraded space environment.

Our potential adversaries have a vote. They pay attention to our advancements in modern warfare and how adept we are at multi-domain integration . . . and also how dependent we have become on space-based effects. In response, they are developing, testing and fielding space capabilities designed to deny, disrupt and degrade the United States' and our Allies' advantages in, through and from space. Simply stated, there isn't a single aspect of our space architecture, to include the ground architecture, that isn't at risk. Today, more than ever, assured access to space is vital for our national security and investments to sustain our advantage are critical. I will specifically address challenges posed by Russia and China as they have deliberate focus and possess specific counter-space programs.

In written comments, Admiral Haney highlighted that Russia is seeking to reassert its great power status. In 2015 we saw Russia continue to streamline and modernize their space industry by merging space, air, air defense and missile defense forces into a unified command. They also integrated the Russian Space Agency with the Russian United Rocket and Space Corporation in order to strengthen government control of the space industry. As Russia demonstrates its resurgent military forces in Syria, we see an increased priority on the development and fielding of advanced military equipment that leverages space to enable long-range precision strike. Furthermore, since 2014, Russia has nearly doubled the number of advanced satellites on orbit, including a new generation of missile warning satellites and geosynchronous signals intelligence collectors. Russia views US dependency on space as an exploitable vulnerability and they are taking deliberate actions to strengthen their counter-space capabilities. Additionally, Russia remains a space launch leader and is currently constructing the Vostochny Cosmodrome to support its human spaceflight activities and heavy lift capabilities to geosynchronous orbit. This indigenous facility allows

Russia to control launches from within their borders and will ultimately replace the Baikonur Cosmodrome in Kazakhstan.

As 2015 came to a close, China formally established its Strategic Support Forces as a separate military service. These forces include China's space, electronic and network warfare capabilities. The reorganization signifies the importance the People's Liberation Army place on space and also their recognition of the congruency between space and cyberspace. China is developing, and has demonstrated, a wide range of counter-space technologies to include direct-ascent kinetic-kill vehicles, co-orbital technologies that can disable or destroy a satellite, terrestrially-based communications jammers and lasers that can blind or disable satellites. Moreover, they continue to modernize their space programs to support near-real-time tracking of objects, command and control of deployed forces, and long-range precision strikes capabilities.

To support Combatant Commanders in the current fight and prepare for challenges precipitated by the CDO environment, we are focused on domain superiority through the following operational objectives: information dominance, mission resilience and the ability to protect and defend space assets. Building strong connective tissue and unity of effort across the DOD, with the IC, IA and our commercial and international partners is foundational to these efforts. The aforementioned operational objectives are enabled by accurate and actionable SSA.

Space Situational Awareness (SSA)

A cornerstone of space domain superiority is SSA and it must be accurate and actionable -- in other words, precise and timely. Accurate and actionable SSA allows us to understand where an object is, what it is, where it is going and its specific intentions.

JFCC Space, through its command and control center, the Joint Space Operations Center (JSpOC), tracks approximately 23,000 objects in orbit . . . we know the actual number of orbiting debris is significantly larger; however, most debris is too small for our current sensor network to

detect and/or maintain custody. This is important since every piece of debris is a potential threat to human spaceflight and operational satellites. The ability to maintain custody of 23,000 objects travelling up to 17,500 mph through some 73-trillion cubic miles of space is a critical and complex endeavor. The corresponding space catalog is a living product and the JSpOC routinely adds hundreds of objects to the database each year. In 2015, for example, the space catalog grew by 861 objects, of which 176 are active satellites and 685 pieces of new debris.

Through a largely automated process, every day, the JSpOC provides an average of 3,300 warnings of close approaches (termed conjunctions). During 2015, the JSpOC received over 120 million observations from the Space Surveillance Network, which resulted in 1.2 million messages to over 600 satellite owner/operators, including US government, commercial and foreign organizations informing decisions on 148 successful collision avoidance maneuvers by owner/operators. The team also provided worldwide notifications for 123 high-interest man-made objects that reentered earth's atmosphere.

As our SSA network is modernized, we will have the capability to detect and track even smaller objects -- vastly expanding the current catalog and likely increasing the number of close conjunctions notifications we send to owners and operators. A notable upgrade is the new Space Fence, which I believe is the most-significant improvement to low- and medium-earth orbit SSA capabilities in decades. By some estimates, the Space Fence will improve our catalog awareness from 23,000 to over 200,000 tracked objects. The delivery of this Kwajalein-based radar in the 2018 timeframe will provide USSTRATCOM's Space component incredible coverage for detection of near-earth objects as well as improved ability to detect unforeseen or unannounced space events such as breakups and maneuvers.

Clearly SSA is more than knowing where an object is in space; when operating in a CDO environment, confirming location is no longer good enough. We must have the capability to

actively search the domain to determine what an object is, understand intentions and characterize vulnerabilities to inform potential countermeasures within tactically-relevant timelines. In this vein, SSA and corresponding sensor tasking is an essential aspect of employing and protecting our national security space assets; therefore, the DOD will always have a primary role in this mission area.

Our foundational SSA architecture -- some legacy, some evolving -- affords a good mix of sensors . . . a combination of both terrestrial and space-based. The important next step is to fuse this sensor data with intelligence information, to include indications and warnings, and to provide a clear operating picture of the domain. Intelligence informs operations and we have more work to do in normalizing space to include providing more intelligence billets and developing more intelligence analysts specifically dedicated to this mission area. Ultimately, through unity of effort with the IC, we can get ahead of potential adversarial action to give our operators and senior decision makers actionable information on tactical timelines.

SSA Partnerships

SSA data sharing hit an all-time high in 2015. You heard from Admiral Haney that we have negotiated sharing agreements with 51 commercial entities, two intergovernmental organizations, and ten nations, plus we are in the process of negotiating additional agreements. This permits information sharing and collaboration with other nations and commercial firms and facilitates responsible space operations by reducing the potential for on-orbit collisions and spectral interference.

Last year, United States Strategic Command also expanded the Combined Space Operations (CSpO) concept to include New Zealand. During the October 2015 Principals meeting in New Zealand, the FVEY partners agreed to a CSpO Vision 2025 that reinforces our efforts to assure the strategic advantage of space through enduring partnership. Together, we are working an aggressive

timeline to meet initial priority objectives for continued collaboration in multiple space mission areas including SSA, Satellite Communications Electro-Magnetic Interference, Global Positioning System/Precision Navigation and Timing and Overhead Persistent Infrared. Longer term goals include working towards integrating and leveraging combined capabilities. The end state to achieve this vision requires interoperable systems that enable space battle management command and control supporting global synchronized operations.

Commercial Integration Cell (CIC)

JFCC Space directed a 6-month pathfinder to explore the technical and legal aspects of a partnership between DOD and Industry, leveraging mutual capabilities and information to enhance awareness in the space domain. The CIC allows for rapid identification, diagnosis and resolution of on-orbit events, especially as space becomes more congested and contested. Partnerships with like-minded commercial space operators establish positive norms of behavior in the space domain while also increasing the overall resilience of USG satellite operations.

The CIC is a method of pursuing greater cooperation and synergy in the space environment by integrating liaison personnel from the commercial sector within the JSpOC. Through an innovative Cooperative Research and Development Agreement (CRADA) structure, we've established a framework that allows and encourages two-way technology and information transfer to support space flight safety. The first few months of the pathfinder explored concepts to improve collision assessment processes, interference resolution, and crisis response actions. By leveraging industry subject matter experts, JFCC Space is improving processes to benefit all space-faring nations. For example, a representative industry operations center has offered to provide their position information and maneuver schedules to better inform our collision assessment process. Through our partnership, we've established better automation and data transfer standards which will ultimately lead to fewer military personnel required in this space safety role.

Our 6-month pathfinder was evaluated for its value by both industry and JFCC Space. The initial results exceeded initial expectations and all agreed to continue the CIC. Industry has gained valuable insight into JFCC Space processes and are better informed and included when detailed planning is necessary to deal with the dynamic space environment. USSTRATCOM's Space component now has access to industry operators and technology to smartly inform process improvements. The CRADAs are a three-year framework and we will continue to increase levels of cooperation and partnerships. Our goal is to institutionalize partnerships, retain a permanent industry presence in our operations center, and continue to adapt and automate our processes, especially as the number of active satellites, the size of the catalog, and the number of new entrants in space continues to grow.

Intelligence Fusion

Today, victory in battle is determined by those who can best integrate, synchronize, and leverage effects in multiple domains. Timely, accurate, and actionable intelligence is critical to characterize space capabilities, events, and operations. The Space Event Joint Exploitation and Fusion Cell (SE-JEFC) had its first full year of operations in 2015, and they proved critical in bringing together experts from the JFCC Space Intelligence Enterprise, National Air and Space Intelligence Center, National Security Agency, Central Intelligence Agency, Project West Wing, and the National Geospatial-Intelligence Agency. This core group of highly-experienced, matrixed personnel from outside agencies has access to the most sensitive information and is focused on foreign space and counter-space capabilities. Additionally, our Space Intelligence Preparation of the Battlespace team gleans information generated throughout the IC and organizes it online to efficiently support space-related campaign planning and operational decision making across all of the Combatant Commands. We are also exploring concepts to make more of this information available to our close coalition and allied partners.

OPIR Battlespace Awareness Center (OBAC)

The men and women of JFCC Space continue to maximize partnerships and leverage capabilities of our national Overhead Persistent Infrared (OPIR) missile warning capability to provide critical missile warning reports to national leaders and Combatant Commands. In 2015, over 10,694 infrared events were detected . . . twenty four percent more than the previous year. The OBAC is a new innovative capability analyzing the existing strategic OPIR data to provide additional localized tactical information for combatant commanders. Two months ago, the OBAC began 24/7 operations to provide near-real-time OPIR data exploitation products for situational awareness to joint forces in Iraq, Afghanistan, and most recently in Syria.

Protect and Defend

My charge from Admiral Haney, to protect and defend the space Joint Operational Area, is described in Operations Directive OLYMPIC DEFENDER. As Russia and China actively develop counter-space technologies, it is paramount we maintain the edge -- we help enable this through experimentation, TTP development and active defense of our military systems.

Joint Interagency Combined Space Operations Center (JICSpOC)

To facilitate information sharing and unity of effort across the national security space enterprise, the Director of National Intelligence, USSTRATCOM, the National Reconnaissance Office (NRO) and Air Force Space Command (AFSPC) established a JICSpOC located at Schriever Air Force Base, Colorado. Not only is it staffed by space professionals, but there are also experts from across the IC to make sure we get this right. During the current phase, through increasingly complex vignettes, the team is focused on providing the DoD and IC a robust test and experimentation environment to facilitate TTP development focused on space defense. As new TTPs are developed at the JICSpOC they will be incorporated into JSpOC processes.

Automated Navigation and Guidance Experiment for Local Space (ANGELS)

Air Force Research Laboratory's (AFRL) ANGELS program epitomizes the spirit and value of experimentation. Last year, the JSpOC worked with AFRL and other agencies to conduct 6 ANGELS experiments that provided valuable insight into the TTPs, systems and processes required to operate in a CDO environment. These experiments challenged our understanding of I&W for potential threats, informed us on requirements for actionable timelines and exposed visualization and analysis techniques required for operations in a CDO environment. Control of the ANGELS spacecraft will soon transition to AFSPC and we anticipate conducting additional experiments to develop and refine our TTPs.

Geosynchronous Space Situational Awareness Program (GSSAP)

Since the GSSAP Initial Operational Capability was declared in October 2015, the command has been operating this space-based system to augment ground-based sensors for cutting-edge SSA. The GSSAP represents a significant improvement in situational awareness in geosynchronous orbit approximately 22,000 miles away. Currently consisting of two satellites, the GSSAP helps protect our assets in geosynchronous orbit; they provide us a "neighborhood watch" capability and also enable satellite anomaly resolution. The GSSAP permits Rendezvous and Proximity Operations (RPO) allowing operators to maneuver the satellites to optimal vantage points for collecting images when required.

JFCC Space, 14AF, and JSpOC Consolidation

A significant milestone to achieve true BMC2 of space involves the consolidation of JFCC Space, 14AF and JSpOC personnel into a single, modern facility. Currently our 230 Joint and Service staff and the 400 JSpOC personnel (137 Officers, 216 Enlisted, and 47 Civilians) work in separate buildings that are approximately two-miles apart. My current headquarters also shares spaces with the host wing -- the 30th Space Wing -- which, is also separated from its units. Additionally, the current JSpOC resides in a refurbished Titan booster processing hangar and,

while it has served us well these past 9 years, this repurposed hangar cannot meet future power and communications requirements. Last year we secured a $61M contract to build out and refurbish an existing building for the JSpOC. We anticipate construction will be complete in 2018, followed by communication equipment installation and final JSpOC move in 2019.

JSpOC Mission System (JMS)

The completion of JMS Increment 2 will allow the JSpOC to transition from an unsustainable and non-upgradable legacy space catalog system to a modern system that will be able to exploit data from future sensors like the Space Fence and other sensors to improve SSA in a CDO environment. Additionally, the legacy mission system does not provide BMC2 functionality. The objective that separates JMS from legacy systems is that we are fielding JMS from inception with a focus on a CDO environment to provide a sophisticated, open architecture system. I look forward to the implementation of JMS Increment 2 and then the delivery of the follow-on system, with modern software architecture to enable advanced BMC2 capabilities.

Conclusion

I remain focused on preserving the peaceful use of space, while absolutely maintaining freedom of action in the space domain and on providing unfettered support to the Combatant Commanders – wherever and whenever our Forces need space effects. At the same time, I am preparing for the future to ensure we maintain our operational advantages in the domain. We will continue to develop new TTPs, employ new technologies, foster collaboration and, most importantly, unleash the power of innovation. I thank the Committee for your continued support and partnership to ensure freedom of action in space and the corresponding ability to provide critical capabilities to the Joint Force and our Nation.

Lieutenant General David J. Buck

Lt. Gen. David J. Buck is Commander, 14th Air Force (Air Forces Strategic), Air Force Space Command; and Commander, Joint Functional Component Command for Space, U.S. Strategic Command, Vandenberg Air Force Base, California.

As the U.S. Air Force's operational space component to USSTRATCOM, General Buck leads more than 19,500 personnel responsible for providing missile warning, space superiority, space situational awareness, satellite operations, space launch and range operations. As Commander, JFCC SPACE, he directs all assigned and attached USSTRATCOM space forces providing tailored, responsive, local and global space effects in support of national, USSTRATCOM and combatant commander objectives.

General Buck received his commission in 1986 as a distinguished graduate of Officer Training School. His career spans a wide variety of command, operations, test and evaluation, and staff assignments. He has commanded at the squadron, group and wing levels. His operational experience includes missile operations, space launch and range operations, satellite command and control, space force enhancement, and space control. General Buck served on The Joint Staff as principal military advisor to The Chairman of The Joint Chiefs of Staff for Coalition Management. In 2010, he deployed to Southwest Asia as the Director of Space Forces for U.S. Air Forces Central. Prior to assuming his current position, General Buck was the Vice Commander, Air Force Space Command.

EDUCATION

1986 Bachelor of Science degree in Business Administration, Summa Cum Laude, Kansas Newman University, Wichita, Kan.
1988 Master of Business degree in Administration, University of South Dakota, Vermillion. S.D.
1991 Distinguished Graduate, Squadron Officer School, Maxwell AFB, Ala.
1997 Master of Science degree in National Security and Strategic Studies, Naval War College, Newport, R.I.
2003 Distinguished Graduate, Master of Science degree in National Resource Strategy, Industrial College of the Armed Forces, Fort Lesley J. McNair Washington, D.C.
2007 Air Force Senior Leadership Course, Center for Creative Leadership, Greensboro, N.C.
2008 National Security Management, The George Washington University, Washington, D.C.
2009 Enterprise Leadership Seminar, University of Virginia, Charlottesville
2009 Program of Senior Executive Fellows, Kennedy School of Government, Harvard University, Cambridge, Mass.

ASSIGNMENTS

1. October 1986- September 1991, Missile Combat Crew Commander, Standardization Evaluation Combat Crew Commander and Emergency War Order Instructor, 44th Strategic Missile Wing, Ellsworth AFB, S.D.
2. September 1991-August 1993, Top Hand Professional Development Program, 576th Test Squadron, Vandenberg AFB, Calif.
3. August 1993- July 1996, Aide-de-Camp, 20th Air Force, F.E. Warren AFB, Wyo.
4. July 1996- June 1997, student, College of Naval Command and Staff, Newport, R.I.
5. June 1997- June 1999, Chief, Current Force Application, Headquarters Air Force Space Command, Peterson AFB, Colo.
6. June 1999- June 2000, Speechwriter, Commander's Action Group, Headquarters Air Force Space Command, Peterson AFB, Colo.
7. June 2000- July 2002, Commander, 1st Space Launch Squadron, Cape Canaveral AFS, Fla.
8. July 2002- June 2003, student, Industrial College of the Armed Forces, Fort Lesley J. McNair, Washington, D.C.
9. June 2003- June 2005, Chief, Multilateral Affairs Division, (J5), Joint Staff, the Pentagon, Washington, D.C.
10. June 2005- June 2006, Commander, 821st Air Base Group, Thule AB, Greenland.
11. June 2006- August 2007, Deputy Director of Strategic Plans and Programs, Headquarters Air Force Space Command, Peterson AFB, Colo.
12. August 2007- June 2008, Vice Commander, 50th Space Wing, Schriever AFB, Colo.

13. June 2008- April 2010, Commander, 30th Space Wing, Vandenberg AFB, Calif.
14. May 2010- May 2011, Director of Space Forces, U.S. Air Forces Central, Southwest Asia
15. June 201 -May 2013, Vice Commander, U.S. Air Force Warfare Center, Nellis AFB, Nev.
16. May 2013- August 2014, Director of Air, Space and Cyberspace Operations, Headquarters Air Force Space Command, Peterson AFB, Colo.
17. August 2014- August 2015, Vice Commander, Air Force Space Command, Peterson AFB, Colo.
18. August 2015- present, Commander, 14th Air Force (Air Forces Strategic), Air Force Space Command, and Commander, Joint Functional Component Command for Space, USSTRATCOM, Vandenberg AFB, Calif.

SUMMARY OF JOINT ASSIGNMENTS
June 2003- June 2005, Chief, Multilateral Affairs Division, Directorate for Strategic Plans and Policy (J5), Joint Staff, the Pentagon Washington, D.C., as a colonel

BADGES
Master Space Operations Badge Master Missile Operations Badge Basic Cyberspace Operator Badge

MAJOR AWARDS AND DECORATIONS
Defense Superior Service Medal with oak leaf cluster
Legion of Merit Medal with two oak leaf clusters
Bronze Star Medal
Defense Meritorious Service Medal
Meritorious Service Medal with four oak leaf clusters
Joint Service Commendation Medal
Air Force Commendation Medal with oak leaf cluster
Air Force Achievement Medal with oak leaf cluster

OTHER ACHIEVEMENTS
2010 Air Force Association's California Military Member of the Year
2013 Gen. Jerome F. O'Malley Distinguished Space Leadership Award

EFFECTIVE DATES OF PROMOTION
Second Lieutenant June 10, 1986
First Lieutenant June 10, 1988
Captain June 10, 1990
Major Aug. 1, 1996
Lieutenant Colonel May 1, 2000
Colonel July 1, 2005
Brigadier General May 6, 2011
Major General Aug. 8, 2014
Lieutenant General Aug. 14, 2015

Statement for the Record

before the

House Armed Services Committee

Subcommittee on Strategic Forces

on the

Fiscal Year 2017 Budget Request for National Security Space Programs

Robert Cardillo

Director, National Geospatial-Intelligence Agency

15 March 2016

Introduction

Chairman Rogers, Ranking Member Cooper and distinguished members of the Committee, I am pleased to testify before you today.

As the nation's primary provider of Geospatial-Intelligence (GEOINT) for the Department of Defense (DOD) and the Intelligence Community (IC), the National Geospatial-Intelligence Agency (NGA) is a regular user and consumer of space-borne sensors and services that enable us to perform missions and activities that include foreign intelligence, mapping, targeting, and safety of navigation.

As such, I appreciate the opportunity to appear alongside my colleagues to discuss the importance of supporting the President's FY2017 budget request for defense space programs. The proposed budget contains the resources we need to upgrade and integrate the nation's security space program to be relevant and ready to counter and survive current and future threats. It also includes funds that will allow us to expand GEOINT access to a broader range of users and to integrate and expose as much GEOINT content as feasible through secure, cloud-based information systems. Furthermore, the budget request will give NGA the ability to take greater advantage of commercial sources to increase persistence and to leverage information from the open, unclassified realm in tandem with the exquisite capabilities of classified government platforms and systems.

Such investments are critical in an era in which our nation faces more diverse crises than any other time during the past half century. ISIS attacks in Iraq and Syria, refugee migration, continued threats of aggression from Russia and North Korea, China's moves in the Spratly Islands, cyber-attacks from faceless antagonists, and international criminal networks are just a few examples of the many challenges to our national security.

GEOINT provides key insight and warning to our policy makers and warfighters, who need such information to effectively deal with problems such as these. Likewise, GEOINT provides our military the navigation, targeting, mapping, and imagery data they need to operate and succeed in this era of complex global and diverse threats.

Government and Commercial Space-Based Assets

To meet their needs, NGA and the National System for GEOINT depend heavily upon government and commercial space-based assets. Many of the government platforms that we rely upon are provided by the National Reconnaissance Office (NRO). These systems are critical to meeting many of our national security requirements, and the importance of their unique and extraordinary capabilities cannot be overstated.

Likewise, commercial space-based imagery platforms continue to increase their value, particularly to provide unclassified GEOINT products for U.S. government, military, state, local, and public use. Commercial imagery enables high-quality shareable GEOINT products current enough to provide a common operating picture when our forces are working with multinational coalitions. Furthermore, approximately 90 percent of the imagery needed for NGA's foundational GEOINT – the information behind our mapping, navigational and aeronautical charts, geodesy and other scientific earth science applications – is derived from commercial imagery sources.

These same commercial space assets enabled NGA to provide crisis support to federal, state, and local first responders during several recent natural and man-made disasters. During the 2015 Alaska wildfires, NGA partnered with the National Interagency Fire Center to provide geospatial and imagery analysis on more than 60 high-priority wildfire sites to support disaster relief and rescue efforts. NGA also supported the Federal Emergency Management Agency in fiscal year 2015 with flooding and damage assessments in South Carolina and Georgia.

By leveraging the unique capabilities of both commercial space-based imagery platforms and National Technical Means systems, NGA is able to balance our collection efforts to meet critical intelligence and military requirements in the most effective and efficient manner. Even as the commercial satellite industry expands, it is increasingly clear that future commercial capabilities will only complement, and never replace our exquisite national capabilities. No matter how much commercial imagery improves in quality and quantity, I cannot envision a time when NRO's expert capabilities and high performing assets will not be an important source.

Considering the importance of space-based assets to our GEOINT efforts, I

would like to highlight the Director of National Intelligence's 2016 Worldwide Threat Assessment, which notes that "threats to our use of military, civil, and commercial space systems will increase in the next few years as Russia and China progress in developing counterspace weapons to deny, degrade, or disrupt U.S. space systems." As foreign governments develop and deploy counterspace weapon systems capable of jamming, damaging, or destroying our space systems, we must remain committed to developing an adaptable and resilient space and ground architecture that can survive threats from our adversaries.

Global Positioning System

In addition to imagery platforms, NGA provides critical technical support to another space-based asset of note – the NAVSTAR Global Positioning System (GPS). GPS is a widely used aid for navigation, land surveying, map making, targeting, and various scientific uses. It provides a reliable 3-dimensional (3D) positioning capability as well as precise timing information used in many applications, including synchronization for cellular networks and wireless carriers in a multitude of countries. GPS and the rest of our space assets provide our military the "ultimate high ground" with an upper hand over the rest of the world.

NGA is also partnered with DOD to develop and maintain the World Geodetic System 1984 (WGS 84) as the standard geodetic frame of reference. WGS 84 provides a single, common, accessible 3D coordinate system and datum to reference and exchange GEOINT and data collected from a broad spectrum of sources used in geodesy, targeting, navigation, aviation, and geography. In recent years, we have increased the accuracy of WGS 84 from distances measured in meters down to centimeters, enabling a 30 percent increase in accuracy of DOD inertial navigation systems, such as those used on strategic bombers.

Expanding GEOINT Access

The President's budget request for FY2017 includes funds that support current and future space-borne assets used by NGA. It also includes resources to enable NGA to expand access to GEOINT on both classified and unclassified systems, and to take important new steps that will better integrate non-traditional sources and services into

our GEOINT efforts.

For instance, NGA is leading the IC's move to a cloud-based environment that allows users to access timely GEOINT from a common desktop environment, regardless of their physical location or agency affiliation. In early FY2016, we met our initial goal to deploy the IC Desktop Environment (IC DTE) to all NGA and Defense Intelligence Agency employees, totaling approximately 50,000 users. Currently, we are upgrading security features with a Phase 2 version of IC DTE and will migrate approximately 75,000 more users by the end of FY2017. Our goal is to have the entire IC population using a common set of office automation, communication, and collaboration tools to increase information sharing, collaboration, and interoperability by the end of FY2020. In addition, last fall, NGA released adaptive versions of The Globe, the website access point to our data, ensuring users can effectively access our information regardless of their computing systems, bandwidth, or classification level.

Commercial GEOINT Capabilities

NGA is taking steps to harness the unprecedented bow wave of GEOINT offerings from established and emerging commercial providers. The small satellite revolution is both intriguing and inspiring, and we are approaching this as an opportunity to expand global coverage. As NGA takes advantage of expanding commercial capabilities and integrates them into the broader GEOINT enterprise, the warfighters' abilities to directly access GEOINT products and services will also increase. We will provide them more access to harder targets and areas, and enable them to operate with greater awareness in rapidly-changing environments.

As commercial offerings continue to evolve from providing primarily imagery pixels to offering imagery-based analytics and services, NGA will seek the optimum mix of commercial sensors, analytic capabilities, services, and delivery methods to maximize success for our customers. Furthermore, our tradecraft will continue to evolve from traditional reconnaissance imagery analysis to the application of geospatial analysis of data and increasingly diverse commercial and national data sources. This will ensure that NGA continues to meet the GEOINT needs of our intelligence, tactical, and foundational GEOINT customers, even as their needs grow and their decision

timelines shrink.

To carry out this shift, we at NGA must understand the implications of the evolution of the commercial GEOINT industry as it occurs. So, we are engaging with emerging commercial GEOINT providers to learn how the industry is maturing, what products and capabilities they are building, and what information they need from us as they develop their satellite constellations and analytic algorithms. NGA is also – in collaboration with our user base and mission partners – experimenting and evaluating ever-evolving commercial GEOINT data and products, analytic services, and knowledge-building methodologies. Ultimately, NGA will acquire commercial GEOINT services that are sufficiently mature and adopt them into our operations.

Likewise, NGA is increasingly operating with and, when necessary, in the open. In September 2015, we launched an unclassified public website to coincide with the President's address at the Conference on Global Leadership in the Arctic: Cooperation, Innovation, Engagement and Resilience (GLACIER). The website (http://nga.maps.arcgis.com) informs and educates audiences by providing significant unclassified Arctic and other geospatial intelligence to the public.

Such efforts demonstrate the power of integrating traditional sources with non-traditional unclassified information. NGA recently completed the first "GEOINT Pathfinder" experiment, which sought answers on several intelligence questions using only unclassified sources such as commercial and civil imagery, open subscriptions, volunteered geographic information, and social media. The team discovered amended maps of the South China Sea that included plans for runways on reefs seven months before construction occurred – information critical to safety of navigation and our armed forces. Needless to say, the potential of using unclassified sources to provide key information like this to the DOD is significant, which is why we will kick off GEOINT Pathfinder 2 later this year.

Conclusion

In closing, the President's FY2017 budget request provides us with the resources necessary to maintain access to a variety of space systems and space-borne products critical to our ability to support warning, targeting, mission planning, mapping, and

safety of navigation. It also supports key investments in technology, workforce talent, and analytic techniques that will produce timely, accurate, and relevant GEOINT for the national security community, international partners, first responders, the warfighter, and the public.

On behalf of the women and men of NGA, thank you for your continued support. I would be happy to answer any questions you may have.

Robert Cardillo
Director, NGA

Mr. Robert Cardillo is the sixth Director of the National Geospatial-Intelligence Agency (NGA). Mr. Cardillo leads and directs NGA under the authorities of the Secretary of Defense and Director of National Intelligence. He became NGA's director on Oct. 3, 2014.

Prior to this assignment, Mr. Cardillo served as the first Deputy Director for Intelligence Integration, Office of the Director of National Intelligence, from 2010 to 2014. In addition, he served as the Deputy Director of the Defense Intelligence Agency (DIA) and the Deputy Director for Analysis, DIA, from 2006 to 2010. In the summer of 2009, Mr. Cardillo served as the Acting J2, a first for a civilian, in support of the Chairman of the Joint Chiefs of Staff. Before he moved to DIA, Mr. Cardillo led Analysis and Production as well as Source Operations and Management at NGA from 2002 to 2006. Mr. Cardillo's leadership assignments at NGA also included Congressional Affairs, Public Affairs, and Corporate Relations.

Mr. Cardillo began his career with DIA in 1983 as an imagery analyst, and he was selected to the Senior Executive Service in 2000. Mr. Cardillo earned a Bachelor of Arts in Government from Cornell University in 1983 and a Master of Arts in National Security Studies from Georgetown University in 1988.

Mr. Cardillo is the recipient of the Director of National Intelligence Distinguished Service Medal, the Presidential Rank of Distinguished Executive, the Presidential Rank of Meritorious Executive, and the Chairman of the Joint Chiefs of Staff Joint Meritorious Civilian Service Award.

Mr. Cardillo resides in Northern Virginia with his wife. They have three children and two grandchildren.

Statement for the Record
Mr. Frank Calvelli
Principal Deputy Director
National Reconnaissance Office

Subcommittee on Strategic Forces
Committee on Armed Services
U.S. House of Representatives
March 15, 2016

Introduction

Chairman Rogers, Ranking Member Cooper, and distinguished Members of the Subcommittee, I am pleased to appear before you today on behalf of the National Reconnaissance Office (NRO) to speak on the subject of NRO's national security space activities. It is an honor for me to appear alongside our mission partners from the Department of Defense (DoD) and the Intelligence Community (IC). The NRO's close relationship and continuing collaboration with all our mission partners is vital to maintaining our nation's superiority in space.

The unclassified nature of today's hearing precludes me from discussing many details of NRO programs, as well as sharing some of our greatest successes. However, I welcome the opportunity to discuss NRO capabilities and the value of NRO contributions to national security in the closed session.

NRO's Critical Mission

Let me start where the Director of National Intelligence left off last month when he testified before the House Permanent Select Committee on Intelligence on the litany of challenges the United States' national security enterprise is facing today – a resurgent Russia increasingly assertive in Eastern Europe, Asia, and the Middle East; a China that continues advancing its military capabilities while aggressively pursuing territorial claims in the Pacific; a North Korea that recently boasted of its successful testing of a nuclear device; an Iranian regime that continues to sponsor terrorist groups around the world, including Hamas and Lebanese Hizballah; and the spread of ISIL, which he referred to as the "pre-eminent global terrorist threat." Critical to addressing these challenges and to countering the resultant threats are robust intelligence,

reconnaissance, and surveillance (ISR) systems that provide decision makers the information they need to prevent or respond to crises. This is where the NRO has proven vital.

Overhead reconnaissance developed, acquired, launched, and operated by the NRO enables the United States (U.S.) and its Allies to maintain strategic, operational, and tactical superiority across a broad spectrum of missions around the globe. It is the foundation of U.S. global situational awareness, providing unique, timely access to locations around the world. NRO systems assist national policy formulation in addition to intelligence, military, and homeland security operations, without risk of putting U.S. military personnel in harm's way. The NRO's increasingly diverse sensor systems provide its customers with unprecedented flexibility and enables intelligence integration, assessment, and problem solving across geographic boundaries and intelligence domains. And it can bring these capabilities to bear on a particular problem at the speed of tasking. These capabilities contribute directly to our nation's ability to achieve diplomatic goals, deter aggression and proliferation of weapons of mass destruction, combat terrorism, and conduct security operations worldwide.

This year marks the 25th anniversary of Operation Desert Storm; since that conflict the NRO has become a key global military operations enabler and many of NRO's capabilities are integral to U.S. and Allied efforts in Afghanistan and other theaters. In addition to traditional NRO ISR systems and support, we provide a wide array of focused capabilities to help solve specific, critical ISR needs for deployed personnel around the world. We've brought dozens of innovative ISR solutions to the fight. These services, products, and tools directly contribute to the highest priority missions, to include:

countering Improvised Explosive Devices; identifying and tracking High-Value Targets; and improving battlespace awareness. NRO Director Betty Sapp recently visited Afghanistan and was humbled to hear how deployed NRO personnel and capabilities are directly impacting the fight in Afghanistan, helping to enable combat operations, and saving U.S. and Coalition lives.

One of the most important capabilities we provide to any fight is our people - our on-site problem solvers. In concert with our mission partners, we provide direct support to the Combatant Commands, their Service and Functional Components, and deployed tactical units. We provide a wide array of capabilities, products, and services to include education, training, exercise support, and subject matter expertise on NRO systems, capabilities, data, and derived intelligence products. We also conduct operational coordination, assist with collection strategies, and provide innovative technical solutions to challenging intelligence, surveillance, and reconnaissance needs. To do this, our Field Representatives, military and civilian NRO subject matter experts assigned to these units, reach back to the NRO, leveraging the breadth and depth of expertise that the NRO enterprise possesses.

NRO Field Representatives have access to the full suite of NRO capabilities, including the Fusion Analysis and Development Effort (FADE). FADE develops customized tools and multi-intelligence analytic methodologies which allow our warfighters to visualize large volumes of data temporally and spatially, establishing patterns of life, and identifying the unusual when it happens, enhancing the ability to find, fix, and finish targets. For example, FADE personnel embedded with the Joint Improvised-Threat Defeat Agency helped identify an explosive

factory in Iraq; leveraging this support, the factory was targeted resulting in multiple militants killed and a substantial amount of weaponry removed from the battlefield.

Another capability having a major impact on operations is Airborne Overhead Cooperative Operations (AOCO). AOCO helps bridge National and Tactical collection platforms to provide the warfighter with near real-time, enhanced geolocations on high-priority tactical missions. In 2015, AOCO improved geolocation accuracy by 75 percent over single sensors, and reduced specific mission planning analysis times by 90 percent.

Finally, the NRO's Joint Collaboration Enterprise and the Integrated Joint Collaboration Cells at Westfields, Aerospace Data Facility East, Aerospace Data Facility Southwest, and the Mission Situational Awareness Cell at Aerospace Data Facility Colorado enable direct support to our warfighters. These collaboration nodes provide warfighters and customers around the globe with real-time access to overhead service and 24/7 expertise to maximize the application and utility of NRO capabilities.

Unfortunately this setting does not allow me to share the NRO's greatest successes, but I am proud to share just a small part of what we bring to the fight.

NRO's Acquisition Excellence

In order to keep pace with changing target and threats, the NRO continues to incorporate new technologies and deliver a more capable, integrated, resilient, and affordable architecture. We are able to do this by leveraging our unique blend of engineering skills, a vigorous research and development program, ground station operational excellence, and specialized sensor data processing capabilities. We are committed to smart

acquisition investments and practices to ensure continued global coverage and availability of our vital national security systems and we work tirelessly to continue to deliver these systems on time and within budget.

NRO manages the majority of the IC's major systems acquisitions (MSA). Currently 17 of our 18 MSAs are "green" in terms of acquisition performance, meeting or exceeding 25 of 27 (93%) cost and schedule performance metrics. The NRO also continued its record of success in financial management. For the seventh year in a row, the NRO received a clean audit opinion on our financial statements - a truly unprecedented accomplishment within the IC. I am equally pleased to report that the auditor's independent review also resulted in the downgrade of a long-standing material weakness over our Property Plant and Equipment cost accumulation environment, one we have had since 2003, and the remediation of a material weakness related to NRO accounting policies, guidance, and methodologies. The NRO has no remaining material weaknesses over financial reporting.

As perhaps a more visible testament to NRO's excellence in resource management, this past October the NRO successfully delivered and launched a new satellite into orbit, as well as an auxiliary payload that carried 13 CubeSats to space. The NRO sponsored nine of the CubeSats while the National Aeronautics and Space Administration (NASA) sponsored the remaining four. The missions of these CubeSats included user software-defined radios to provide beyond-line-of-sight communication for disadvantaged users in remote locations, and technology pathfinders to demonstrate tracking technologies, optical communications, and laser communication. Last month, we launched the first of four satellites planned for 2016 - a busy year for our Office of Space Launch and others. Each of these launches is

a visible testament to the diligent efforts of our program teams who successfully acquire and deliver these complex systems; each signifies enhanced intelligence capabilities for the warfighter and improved decision advantage for our analysts and policy-makers.

The NRO also remains a committed launch customer; our highest priority remains our assured access to space through reliable providers with predictable costs. We partner closely with the Air Force and continue to rely on Air Force-certified launch providers to successfully put our critical national security payloads in orbit. We are committed to working with the Air Force, NASA, and commercial space providers to ensure our nation's launch and space industrial base can meet our mission requirements. As we transition to new and upgraded domestic launch vehicles, we remain concerned that restrictions to the availability of the launch vehicles we currently rely on to deliver our payloads could significantly increase costs and slip schedules.

NRO Strategic Thrusts

Director Clapper noted in his Congressional testimony last month that "unpredictable stability has become the 'new normal' and this trend will continue for the foreseeable future," which means the NRO's capabilities need to keep getting better and faster. In order to do this and stay ahead of our adversaries, we are focused on delivering (1) increased performance in space, (2) increased capability on the ground, and (3) improved architectural resiliency and protection in order to continue to meet the challenges of our dynamic operations environment and address the nation's highest priority problems.

We are improving the persistence of our space-based systems, providing greater "time on target" to observe and characterize activities, and the potential relationship between activities, and to hold even small, mobile targets at risk. We are increasing the capabilities and sensitivities of our systems by incorporating new technologies in space, and on the ground. New technology, enabled by Research and Development (R&D), is absolutely essential here and our superb R&D team collaborates with American entrepreneurs to find ways to do from space, what others think impossible to do anywhere.

We are building ground systems today that allow capabilities that could not have been imagined just a few years ago. Sentient - a "thinking" system that allows automated, multi-intelligence tipping and cueing at machine speeds - is just one of those capabilities. Further, our Future Ground Architecture will transform our ground architecture into an integrated enterprise which empowers users of all types with the capabilities to receive, process, and generate tailored, timely, highly-assured, and actionable intelligence.

We are enhancing our ability to provide all decision makers, from senior policy makers to deployed warfighters, the ability to visualize intelligence information both temporally and spatially, making the connections more apparent. And we are investing substantial dollars in the resiliency of our ground and space-based systems to ensure we continue to deliver our mission, regardless of the threat environment.

The NRO fully recognizes that space is an increasingly contested and congested environment. Foreign nations understand the incredible decision advantage our capabilities in space provide, which is why they are actively pursuing the means to deny our space advantage. For that reason, the NRO is committed

to making its entire mission architecture more resilient; to include developing collection systems with enhanced survivability built-in from the beginning. In short, we are more focused on survivability and resiliency from an enterprise perspective than we have ever been and we have made significant investments to that end. Those investments have been informed by detailed modeling and analysis, and driven by strategy. We have worked this strategy collaboratively with the DoD, the IC, and the broader space community, through various means to include the Joint Interagency Combined Space Operations Center (JICSpOC). One of the JICSpOC's major benefits is that it provides DoD and the IC a robust test and experimentation environment to better integrate our space operations in response to threats; those we face today and those we will face tomorrow. Even though it is fairly new, the JICSpOC is already demonstrating the power of unity of effort and information in space operations.

NRO Workforce

Spanning more than five decades, the men and women of NRO have been and are the keys to NRO's success. That's why the Workforce Stability Initiative (WSI) we began in 2014 is so important. Thanks to the support of the Congress and our mission partners, we stabilized the Central Intelligence Agency (CIA) element of our engineering workforce through the Office of Space Reconnaissance. Then in October we officially established the NRO's first dedicated workforce, NRO's DoD cadre, after developing and implementing new NRO policies, establishing NRO as a parent organization, transferring personnel in the DoD support systems, and establishing funding mechanisms for payroll. These two elements represent about one-third of our

government workforce and will provide us with enhanced stability across core NRO functions. We will also continue to leverage rotational personnel from the CIA and DoD for their broad-based experience and innovation. By establishing a core NRO workforce and also leveraging rotational workforce capabilities, the NRO will continue to have the people necessary to provide the nation with the premier space reconnaissance capabilities for national security.

Conclusion

The men and women of the NRO embody our core values of Personal Integrity and Accountability, Teamwork Built on Respect and Diversity, and Mission Excellence. It is our highly-skilled personnel who go above and beyond to execute our mission to provide "Innovative Overhead Intelligence Systems for National Security." Driven by our extraordinary people, the NRO will continue on the path of delivering acquisition and operations excellence, as well as the unparalleled innovation that is the hallmark of our history and the foundation of our future. We encourage you to continue visits to the NRO, our mission ground stations, and satellite factories to meet our talented workforce and for detailed discussions on how our systems directly support the national security of the United States.

Mr. Chairman and members of the Subcommittee, thank you for your continued support of the National Reconnaissance Office and the opportunity to appear before you today.

Frank Calvelli
Principal Deputy Director, NRO

Mr. Calvelli was appointed the Principal Deputy Director, National Reconnaissance Office (PDDNRO) on July 6, 2012. As the PDDNRO he provides overall day-to-day management of the NRO, with decision responsibility as delegated by the Director, NRO (DNRO). In the absence of the DNRO, he acts on the Director's behalf on all matters.

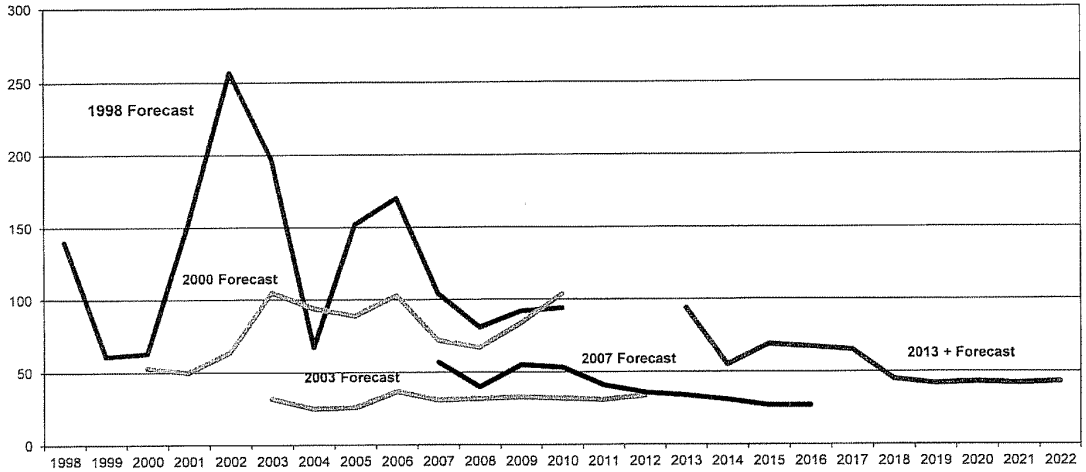
Mr. Calvelli has held a variety of senior positions within the NRO including satellite and ground system acquisition, systems engineering, and mission operations.

Mr. Calvelli has a Bachelor's Degree in Computer Science from the State University of New York at Potsdam, and a Master's in Business Administration from Loyola College in Baltimore.

DOCUMENTS SUBMITTED FOR THE RECORD

MARCH 15, 2016

Commercial Launch Environment



Source: 1998, 2000, 2003, 2007, and 2013 COMSTAC GEO and FAA NGSO Forecasts

- International Launch Providers "Price" for Market Share Capture/National Pride versus Profit
- 30% of Commercial launches are unaddressable for US Launch Vehicles
- *Launch Capacity Exceeds Demand by 3:1 to Service this Fixed market*

WITNESS RESPONSES TO QUESTIONS ASKED DURING THE HEARING

MARCH 15, 2016

RESPONSE TO QUESTION SUBMITTED BY MR. BRIDENSTINE

General HYTEN. The NOAA pilot program is being closely followed by the DOD Weather Enterprise and we eagerly await the results to evaluate where we can benefit from a data acquisition model such as this. The DOD has already taken actions by releasing a Request for Information (RFI), soliciting the industry's intent and ability to develop, launch, and operate space based commercial services that could meet the 11 weather capability gaps identified in the Spaced-Based Environmental Monitoring (SBEM) Analysis of Alternatives (AOA). Based on the industry responses to the RFI, there seems to be a viable existing/emerging vendor market that has the potential to provide the weather data that can satisfy a subset of SBEM AOA weather gaps. We will continue to evaluate the commercial data standards compared to the data currently provided by DOD, civil and international satellites, and determine if any changes in our DOD data enterprise would need to be made to accommodate integration of commercial data. Additionally, we will continue to address operational risks and long-term viability of commercial data sources. [See page 15.]

QUESTIONS SUBMITTED BY MEMBERS POST HEARING

MARCH 15, 2016

QUESTIONS SUBMITTED BY MR. ROGERS

Mr. ROGERS. What is the current state of the space acquisition workforce with regard to numbers of acquisition professionals and their acquisition management expertise? If there are shortcomings in the acquisition workforce, what is being done about them? What efforts are underway to enhance development of the space acquisition workforce?

General HYTEN. The Department of Defense has established a requirement for each acquisition workforce member to meet mandatory acquisition certifications when occupying an Acquisition Professional Development Program (APDP) Coded positions. For Space Program Managers, 97% of the Acquisition Professional Workforce is certified.

The Defense Acquisition Workforce Fund (DAWDF) implements targeted development efforts for the acquisition workforce. These efforts include targeted training for priority skill needs, initials skills courses, continuous learning, recruiting, coaching, training, and mission assistance. Over the past five years the Air Force has been benefited by leveraging over $60M across these efforts.

Mr. ROGERS. Cloud characterization and theater weather imagery are the top two most important certified requirements regarding space-based weather collection. What are the risks if these warfighter requirements are not met?

General HYTEN. The Air Force, other Services and Department of Defense (DOD) continue to assess the impacts of relying on civil and international partner for space-based environmental monitoring capabilities to address cloud characterization (CC) and theater weather imagery (TWI) needs, vice continuing an inherent DOD capability as a follow-on to the Defense Meteorological Satellite Program (DMSP).

At this time, the Joint Requirements Council (JROC) has validated DOD materiel solution needs focused on other capability areas and identified that reliance on civil/international partner capabilities for CC/TWI is acceptable. However, the JROC wants to maintain awareness of issues surrounding those partner capabilities and warfighter concerns, primarily over the Indian Ocean region (JROCM 092–14, dated 3 September 2014). If there is no weather satellite coverage in this theater, warfighter concerns cover the full range of military operations, such as tropical cyclone assessments, resource protection (i.e. warnings for thunderstorms, severe weather, and heavy precipitation) and tactical operations (e.g. aircraft, land and naval maneuvers).

On 3 March 2016, the JROC issued a memorandum titled "Space Based Environmental Monitoring Gap Coverage" (JROCM 012–16) that directs the Air Force, along with the Office of the Secretary of Defense Cost Assessment and Program Evaluation and the Principal DOD Space Advisor's Office, to complete a risk assessment and determine non-materiel options for addressing the CC and TWI gaps, taking into account recent programmatic, threat and operating environment changes. The Air Force's intent is to brief results to the Joint Capabilities Board no later than 1 May 2016, as directed.

Mr. ROGERS. With the delays of both GPS III and OCX, when does the Air Force plan to deploy Military code (M-code) signal capability? What is the risk of not sustaining the current, as well as required, levels of GPS service, and what is being done about this risk? a. What measures is the Air Force taking to address problems with GPS OCX software development in order to minimize further cost and schedule growth?

General HYTEN. At this time, we currently have an M-code test-only capability since we have 19 M-code capable satellites on orbit. In order to deliver an initial operational M-code signal capability, we need an M-code command and control capability in the ground system and a global M-code monitoring network. This is planned to be delivered with OCX Block 1 in July 2021. In order for this signal capability to be operationally useful, we will need fielded M-code capable receivers in DOD weapon systems. The services are mandated to procure only M-code capable receivers after FY17.

The M-Code signal is already being broadcast by 19 satellites (12 Block IIF, 7 Block IIR–M) on orbit, which fulfills the satellite constellation portion of an initial operational M-code capability. While there have been delays in the GPS III pro-

gram, the program is planned to have satellites available for launch ahead of the ground system's capability to launch them.

The Next-Generation Operational Control System (OCX) will provide command, control and mission support for the GPS III and legacy satellites' M-code capability using an expandable robust information assurance architecture. OCX is critical to continuing high priority national efforts to modernize GPS with new military and civil positioning capabilities, including enhanced security, precision, reliability and integrity. As a mitigation of risk for late delivery of OCX, on 3 February, the GPS Directorate put Contingency Ops (COps) on contract with Lockheed Martin. COps is a modification to the legacy ground system that will allow us to command, control and operate the GPS III satellite at a GPS IIF capability-level until OCX Block 1 is ready for operations in July 2021. As a contingency effort, COps does not change M-Code capability; rather, it enables growth of the M-Code capable satellite constellation. COps delivery is planned for April 2019.

Finally, worldwide M-code signal monitoring is a required piece of an operational M-code capability. This capability is projected to deliver as a part of the OCX program in July 2021. We also are studying options for a contingency worldwide M-code monitoring program that could deliver ahead of OCX.

There is no credible risk of not sustaining the current and required level of GPS service because the likelihood is so low. The satellite constellation is healthy, with 31 satellites in service and the requirement is to have a 95% probability of at least 24 operational satellites and a 98% probability of at least 21 GPS satellite constellation slots broadcasting a healthy signal (in order to meet these requirements, the Air Force's practice is to maintain at least 27 operational satellites). GPS III satellites are on track to maintain the current levels of service and provide enhanced anti-jam capabilities for greater resilience. The current ground system is proactively maintained to sustain current operations and shore up cyber defense/security until OCX is operational.

The Air Force has taken a very active role in the management of OCX in order to minimize further cost and schedule growth through three major actions. First, the Air Force increased Government oversight at all levels (PM-weekly, PEO—bi-weekly, AQ—monthly, USD(AT&L) & SECAF—quarterly) to drive contractor performance. Second, we established shoulder-to-shoulder testing with government reps in plant. This helps eliminate coordination and approval delays and provides additional eyes on the processes. Third, we developed technical off-ramps should poor performance continue.

Mr. ROGERS. What is the status of your efforts for consolidating the acquisition of commercial satellite communication services across the Department of Defense into a single program office or under the direction of a senior DOD official?

General HYTEN. The Defense Department is continuing to investigate the courses of action concerning FY16 NDAA Sec 1610 that addressed wideband consolidation, with the Air Force as a stakeholder.

Mr. ROGERS. Please explain how implementation of the Space Enterprise Vision will improve the affordability, resilience, and capability of the future national security space architecture.

The Space Enterprise Vision will drive future operations, acquisitions, and programming decisions which support the national security space architecture. Air Force Space Command is working directly with the National Reconnaissance Office and folding in the Army, Navy and Joint equities per the direction of the Defense Space Council. When AFSPC developed the SEV warfighting construct for space, we identified the need for several follow on studies in order to determine how to attain a resilient and affordable space enterprise before 2030. For example, the strategic missile warning and satellite communication study is currently underway, and will determine how we support the nuclear command and control mission with respect to affordability, resilience, and capability.

Mr. ROGERS. Some assert that "disaggregation" will result in more affordable, capable, or resilient space systems. On what specific analysis(es) is this judgment based? Please provide a copy of the relevant analysis(es) to the committee.

General HYTEN. The Protected SATCOM Services (PSCS) Analysis of Alternatives (AOA) Final Report recently received an assessment from the Office of the Secretary of Defense (OSD)-Cost Assessment and Program Evaluation (CAPE) and was provided to Congress on 18 April 2016. CAPE concluded the AOA complied with the guidance issued and is analytically sufficient to inform future acquisition decisions. While CAPE's assessment called out an aggregated satellite constellation as most cost-effective, the assessment left room for a possible disaggregated constellation based on some additional challenges that are being addressed in two additional studies. Specifically the PSCS AOA Follow-on for Resiliency (PAFR) study and the

Space Enterprise Vision (SEV) Strategic Missile Warning and Satellite Communications Focused Study.

The PAFR Study is nearly complete and will provide additional analysis and recommendations in three key areas:

1) Analyzing and costing specific survivability capabilities for protected SATCOM architectures, 2) Further analyzing follow-on options for the Enhanced Polar System (EPS), and finally 3) Further inform the pros and cons for aggregated and disaggregated space systems.

The current SEV study will provide specific recommendations for a resilient space enterprise that can deter aggression within the space domain and prevail in any high-end conflict that extends to space. This study is using data supplied by previously mentioned studies and the SBIRS Follow-on AOA, and will deliver a strategy for countering threats to the space domain that will take into account any contributions from an aggregated or disaggregated architecture.

Upon completion and approval of the study, we will provide the analysis to the committee.

Mr. ROGERS. What are the challenges in managing multiple new simultaneous satellite procurements?

General HYTEN. The nature of the emerging threats in space will require us to assess the risks in developing and fielding new, resilient capabilities simultaneously. We do not have the luxury of time to field the elements of the Space Enterprise Vision sequentially. The simultaneous approach will enable common technical approaches for resiliency across the various space architectures.

Managing these efforts will require programs to be adequately resourced, both in personnel and funding, to ensure success. Limited resources can severely affect the trade space available to address unforeseen technical or acquisition issues all at the same time. To mitigate this risk, Space and Missile Systems Center has implemented a Tiered approach across the mission areas and programs to ensure resources are allocated to our most critical programs that meet the Space Enterprise Vision, to include both Government and Industry resources.

Mr. ROGERS. Is the Air Force Space Command and the National Reconnaissance Office taking different approaches to improve the resilience and assurance of the national security space architecture? If so, why?

General HYTEN. No. AFSPC and NRO are taking an integrated approach to improve resilience and mission assurance of the national security space architecture. AFSPC and NRO have jointly developed a Space Enterprise Vision that describes a combined approach to improving resilience and mission assurance. The two organizations are in the processes of establishing a joint approach to governing the planning and development of space mission architectures and capabilities to realize these improvements.

Mr. ROGERS. What affect will disaggregation of nuclear and non-nuclear missions have on an adversary's risk calculus regarding attacking U.S. space assets? Will it lead to less complicated and/or lower the threshold for attacking space systems supporting the United States' ability to project power with non-nuclear forces? If so, are you concerned that disaggregation could weaken deterrence and foster crisis instability?

General HYTEN. Credible arguments have been made that support cases both for and against disaggregation versus aggregation of nuclear and non-nuclear missions and the potential impact this one factor could have on adversary decision calculus to attack or refrain from attacking U.S. space assets. Our adversaries understand the competitive advantage we derive from space. Whether our systems are aggregated or disaggregated, all our space systems are being put at risk by various kinetic and non-kinetic threats. While it's possible that disaggregation could lower the threshold for adversaries to attack systems that only support non-nuclear forces, we also have to weigh the possible advantages that disaggregation lowers the risk of adversary attack to space systems dedicated to nuclear warning, and command and control while providing additional options that could increase the resilience capacity and survivability of space systems dedicated to support non-nuclear forces. We need to ask ourselves to what extent would it be prudent to continue to assume that different potential adversaries with different strategic interests and differing decision calculus will decide to refrain from attacking U.S. space systems that support non-nuclear missions because they are aggregated with our space systems that support nuclear command and control and strategic missile warning. It can be credibly argued that aggregation, not disaggregation, may foster increased crisis instability since U.S. policy makers will not be able to discern an adversary's intent if an aggregated space asset was attacked, that is whether or not such an attack was intended to be limited to degrading U.S. non-nuclear forces or whether such an attack was intended to purposefully degrade strategic missile warning and nuclear com-

mand and control assets as a prelude to attacking the United States of America with nuclear weapons.

Mr. ROGERS. Do you support establishing so-called "red lines" through declaratory policy statements to refrain from deliberate interference with nuclear command, control, and communications or early warning space systems?

General HYTEN. Attacks on national or military infrastructure is always a serious matter; however, we must be cautious about formally declaring "redlines." Based on Presidential direction, there are various degrees of consequences we can take militarily when we are attacked, but signaling what those are, or at what point we will take a particular action, does not enhance our deterrent posture. Maintaining a level of opacity is to our advantage. The present state of mutually shared thresholds in space developed over time during the Cold War. It was well understood by all parties that interfering with nuclear command and control or strategic warning systems was extremely risky and could be interpreted as a prelude to conflict. This position was reinforced through treaty agreements and national technical means that created some level of transparency between the United States and the former Soviet Union.

However, in the years since the Cold War, we have seen multiple new actors with the ability to put dangerous capabilities on-orbit or otherwise hold space assets at risk. As the days of mutual bi-lateral balance of power in space faded, so did the ability to effectively establish an "off limits" position with respect to strategic capabilities. Well-known nuclear thresholds can be reinforced, but it must be backed up with the ability, and national will, to respond. This is one of the reasons we must pursue new ways of ensuring these systems can operate effectively despite being threatened or challenged.

Mr. ROGERS. Do you believe that Russia or China will honor international norms to refrain from deliberate interference with nuclear command, control, and communications or early warning space systems in the event of crisis or conflict with the United States?

General HYTEN. Negotiations in the United Nations have shown that Russia and China are resistant to entering into any formal international norms agreement for space. We have seen increasing military "adventurism" from both countries and feel that crossing previously established red-lines would be considered if they felt it was in their best interest and supported bold strategic objectives. It is therefore up to us to deter these actions and communicate our national will to respond.

Effective deterrence is created through a position of strength. We are pursuing new ways to both field the ability to respond and deny the benefits of an attack. We are also being transparent in our plans and actions so that potential adversaries will know that hostile actions in space will not be effective and will have very negative consequences.

Mr. ROGERS. What are you doing to ensure the right policies are in place so that emerging commercial space capabilities help our national security and don't hurt it?

Mr. LOVERRO. The Department recognizes that U.S. national security in space and elsewhere is critically dependent on a robust and innovative commercial sector. A centerpiece of our overall space policy and strategy is to eliminate barriers constraining that innovation. We must balance that interest with any possible negative national security impacts of these activities. This tension has been the focus of departmental thinking over the last three years and is the exact reason why the Secretary and the Administration supported relaxation of commercial remote sensing standards in 2014. As a department, we have aggressively worked with the intelligence community, NOAA, NASA, and the FAA to find ways to approve activities such as on-orbit servicing, commercial SSA, and even on-orbit imaging, establishing the right safeguards to protect national security while enabling commercial innovation.

Beyond simple policy changes, the Department of Defense is also pressing forward with activities to harness better these commercial innovations for DOD use. Such is the purpose of our funded commercial communications pathfinder work and hosted payload concepts being explored in many mission areas. In fact, a key element of our thinking on disaggregation is to open up greater portions of our space architecture to commercial-like solutions.

Finally, we are actively supporting FAA in establishing the right oversight structure for commercial and entrepreneurial space activities that will support necessary flight safety needs to assure that we do not constrain the US commercial space renaissance due to future on-orbit collision risk.

Addressing this challenge is one of the most important strategic tasks facing the Department because too great an erosion of our technological superiority would ultimately undermine our conventional deterrence, contribute to crisis instability, and greatly raise the potential cost of any future U.S. military operation. That's why the

Department is exploring new "offset strategies"—with new combinations of technologies, operational concepts, and organizational constructs—to maintain our ability to project overwhelming combat power into any theater and at the times of our own choosing. This includes reviewing and updating appropriate policies to ensure continuous innovation of commercial space capabilities without adversely affecting national security.

Mr. ROGERS. Some assert that "disaggregation" will result in more affordable, capable, or resilient space systems. On what specific analysis(es) is this judgment based? Please provide a copy of the relevant analysis(es) to the committee.

Mr. LOVERRO. As in most areas, blanket statements on the effectiveness of any tool needs to be carefully examined. This is especially true for disaggregation, which has been used to mean many things in many contexts. The DOD White Paper, "Space Domain Mission Assurance: A Resilience Taxonomy" defines disaggregation as "the separation of dissimilar capabilities into separate platforms or payloads". An example of this would be separating tactical and strategic protected satellite communications.

Disaggregation may serve many purposes, of which cost, capability, and resilience are just some. In the DOD, most discussions of disaggregation, first and foremost, begin with a discussion of the policy and deterrence benefits of separating strategic nuclear warfighting and tactical conventional warfighting capabilities and then examine the resulting cost, capability, and resilience impact of that architectural decision. In the protected communications example, separating tactical and strategic protected satellite communications may help mitigate the risk of uncontrolled escalation during a crisis or conflict without necessarily bolstering resilience.

The exact effects of disaggregation—positive or negative—on resilience, cost, system capability, performance, and other considerations would depend on the specific system and the disaggregation approach. It would be expected that in some cases, disaggregation would actually increase the cost of the total system, although individual system elements might be less expensive. Such was the case in the recently delivered Analysis of Alternatives on Protected Communication, which judged an overall increase in cost to fulfill all protected communication requirements for a disaggregated system, although specific elements, such as the NC3 portion, decreased in cost substantially. On the other hand, the missile warning AOA statement showed little to no increase in overall cost for disaggregation. Both AOA reports have been delivered to Congress.

The bottom line is that disaggregation is just one of several strategies for addressing tension between strategic deterrence, cost, performance, resilience that must be foundational in our future space activities. Disaggregation may cost more in some cases. But this added cost may be acceptable if it restores strategic clarity, reduces the likelihood of unintentional escalation and provides more flexibility for addressing the rapidly changing space threat and technology landscape we expect in the future.

Mr. ROGERS. What affect will disaggregation of nuclear and non-nuclear missions have on an adversary's risk calculus regarding attacking U.S. space assets? Will it lead to less complicated and/or lower the threshold for attacking space systems supporting the United States' ability to project power with non-nuclear forces? If so, are you concerned that disaggregation could weaken deterrence and foster crisis instability?

Mr. LOVERRO. It is accurate that several observers have suggested that disaggregating strategic and tactical space systems may lower the threshold for attacks on the resulting non-nuclear system elements. The converse is also correct that it would raise the threshold for attacks on the nuclear elements. Thus, disaggregating creates greater clarity of adversary intent, increases nuclear stability, reduces the potential for unintended escalation, and assures the President of this ability to command and control strategic forces, but at the expense of a potentially lowered threshold of attack in a non-nuclear elements.

So, any decision to disaggregate must therefore address how that potentially decreased threshold will be restored. Other elements of space mission assurance, such as incorporation of commercial and allied systems, defensive measures, proliferation, and diversity may be required to address that consequence. Each of these elements provides added strategic benefit, in addition to the ultimate benefit of strategic clarity and avoidance of unintended escalation that current aggregated architectures pose.

Mr. ROGERS. Do you support establishing so-called "red lines" through declaratory policy statements to refrain from deliberate interference with nuclear command, control, and communications or early warning space systems?

Mr. LOVERRO. Removing ambiguity, especially as it relates to nuclear command, control, and communication and missile warning, can greatly enhance stability and

reduce the likelihood of unintentional crisis escalation. However, the method used to remove ambiguity is also important. So called "red lines" have not been demonstrated to achieve consistently the strategic benefits desired. Thoughtful and deliberate bi-lateral discussions that ensure our position about nuclear-related space systems is clear, complimented by clear lines of distinction in system character, are more likely to achieve a meaningful understanding of restraint.

Mr. ROGERS. Do you believe that Russia or China will honor international norms to refrain from deliberate interference with nuclear command, control, and communications or early warning space systems in the event of crisis or conflict with the United States?

Mr. LOVERRO. Norms of behavior shape the international community's understanding of responsible and irresponsible behavior in outer space and of expected reactions if these norms are broken. By establishing clear U.S. norms against purposeful interference with nuclear command, control, and communications or early warning space systems, then a country violating those norms would be sending a clear signal of its intentions. The Administration would take very seriously any interference with the nuclear command, control, and communications and early warning space systems of the United States and our allies, whether in peacetime, crisis, or conflict, and may consider such action to be escalatory in nature. But we must be clear on norms in and of themselves will not dissuade an adversary intent upon escalating conflict to nuclear levels from attacking U.S. strategic space system. They clarify understanding on both sides, just as it was the case during the Cold War, but must be backed up by other means to assure strategic space services can continue to support U.S. strategic needs even following attack.

Mr. ROGERS. The committee has been informed that the only remaining strategic radiation hardened microelectronics foundry does not have enough orders to remain economically viable after this year. What options does DOD have to ensure access to strategic radiation hardened microelectronics—both now and if this foundry closes? What level of funding would be necessary to keep that foundry open, and what resources would be necessary to ensure the long-term viability of that source?

Mr. LOVERRO. The Department is acutely aware of this issue and USD(AT&L) is leading the effort to actively address it. The Department will follow its policy, guidance, and best practices as described in DOD Instruction 5000.60, "Defense Industrial Base Assessments," July 18, 2014. AT&L is pursuing a number of Department-wide and program specific methods to address this problem such as, where appropriate, lifetime buys or tailored assurance activities for non-US success. AT&L is best positioned to provide details on specific strategies and funding needs.

Mr. ROGERS. What is the current state of the space acquisition workforce with regard to numbers of acquisition professionals and their acquisition management expertise? If there are shortcomings in the acquisition workforce, what is being done about them? What efforts are underway to enhance development of the space acquisition workforce?

Mr. WEATHERINGTON. The Department's budget request would ensure the acquisition workforce remains mission capable. While the Department tracks the qualifications and expertise of its overall acquisition workforce, it does not subdivide the workforce by domain (e.g, ships, aircraft, space). As such we do not track a "space acquisition workforce" separately. DOD has established a requirement for each acquisition workforce member to meet mandatory acquisition certifications when occupying an Acquisition Professional Development Program (APDP) Coded positions. For Space Program Managers, 97% of the Acquisition Professional Workforce is certified.

The Defense Acquisition Workforce Fund (DAWDF) implements targeted development efforts for the acquisition workforce. These efforts include targeted training for priority skill needs, initials skills courses, continuous learning, recruiting, coaching, training, and mission assistance. Over the past five years the Air Force has been benefited by leveraging over $60M across these efforts.

Mr. ROGERS. Cloud characterization and theater weather imagery are the top two most important certified requirements regarding space-based weather collection. What are the risks if these warfighter requirements are not met?

Mr. WEATHERINGTON. If these warfighter requirements are not met by civil or international assets once the Defense Meteorological Support Program ends, the Department of Defense may experience decreased battlespace awareness for imaging quick-moving weather systems such as thunderstorms, dust storms, frontal activity or tropical cyclone assessments, and worldwide cloud forecasting. Missions such as resource protection, transiting aircraft and shipping, anti-submarine operations, Intelligence Surveillance, and Reconnaissance collections, and Navy/Army/Air Force Coalition tactical operations could be moderately affected. Central Command, Pacific Command, and Africa Command would be most impacted by the increased risk of

these gaps not being met, primarily over the Indian Ocean region. Worldwide coverage in austere and data-sparse areas benefits most from space-based weather collection. The Department is currently re-addressing the requirements for cloud characterization and theater weather imagery.

Mr. ROGERS. What is the status of your efforts for consolidating the acquisition of commercial satellite communication services across the Department of Defense into a single program office or under the direction of a senior DOD official?

Mr. WEATHERINGTON. [The information referred to is classified and retained in the committee files.]

Mr. ROGERS. Some assert that "disaggregation" will result in more affordable, capable, or resilient space systems. On what specific analysis(es) is this judgment based? Please provide a copy of the relevant analysis(es) to the committee.

Mr. WEATHERINGTON. Disaggregation has been used to mean many things in many contexts, resulting in considerable confusion surrounding the term. In September 2015, the Office of the Assistant Secretary of Defense for Homeland Defense and Global Security authored the Department of Defense White Paper, 'Space Domain Mission Assurance: A Resilience Taxonomy', in order to provide a standard lexicon for space domain mission assurance. According to this taxonomy, "Disaggregation is defined as the separation of dissimilar capabilities into separate platforms or payloads. An example of this would be separating tactical and strategic protected satellite communications. It should be noted that disaggregation may serve, and be justified by, a variety of purposes that are worthy in and of themselves, but which may not relate to resilience. Separating tactical and strategic protected satellite communications, for example, may help mitigate the risk of uncontrolled escalation during a crisis or conflict without necessarily bolstering resilience. Further, disaggregation can also apply in other cases to reduce the complexity of systems, making it easier to implement other resilience characteristics. In this respect, disaggregation is a means to an end; not bolstering resilience directly, but allowing it to occur more readily."

The exact effects of disaggregation—positive or negative—on resilience, cost, system capability, performance, and other considerations would depend on the specific system and the disaggregation approach. For example, two recently concluded Analyses of Alternatives (AOA)—one for Protected Satellite Communications Systems and a second for Space Based Infrared System Follow-on—examined the trade-offs of some disaggregated architectures among the possible alternatives. The final reports for these AOAs have previously been provided to Congress.

Mr. ROGERS. What are the challenges in managing multiple new simultaneous satellite procurements?

Mr. WEATHERINGTON. Even as we complete deployment of our current satellite constellations, we are deliberately planning for procurement of the replenishments/replacements for our Military Satellite Communication, missile warning, and weather capabilities. This planning addresses a number of architectural and business challenges.

We are evaluating resiliency measures against jamming, cyber, and on-orbit threats. We are assessing the value of disaggregation for resiliency, strategic messaging, and reducing costs. In addition, we are balancing the strategies of leveraging commercial and international capabilities versus maintaining inherent U.S. Department of Defense capabilities. We are evaluating insertion of newer technologies to meet emerging Department needs ?versus acquiring functional equivalents, which could result in less cost, schedule, and technical risk. As always in our major defense acquisition programs, we are enabling competition to the maximum extent possible and paying attention to industrial base issues and considerations. We are assessing the prioritization of systems in terms of risk and threats to ensure limited Department resources are available to study, evaluate, and execute systems. Capability options for systems selected will be applied in the most effective and efficient manner.

Mr. ROGERS. The committee has been informed that the only remaining strategic radiation hardened microelectronics foundry does not have enough orders to remain economically viable after this year. What options does DOD have to ensure access to strategic radiation hardened microelectronics—both now and if this foundry closes? What level of funding would be necessary to keep that foundry open, and what resources would be necessary to ensure the long-term viability of that source?

Mr. WEATHERINGTON. No strategic radiation hardened microelectronics foundry has notified its Department of Defense customers of a decision to discontinue operations or the end-of-life of specific parts or processes. If and when one does, the Department will follow defense industrial base assessments and the diminishing manufacturing sources and material shortages processes that provide a range of mitigation options, such as life time buys. Estimated costs associated with maintaining

foundry capabilities and access required for the production of the parts required by Department customers cannot be calculated without foundries providing additional business and technical information. These estimates vary widely and depend to a great extent on the commercial marketplace's support of specific process technologies, feature sizes, and performance features.

Mr. ROGERS. What are the foreign threats to our space systems? What are we doing about the growing foreign threat to our space systems?

General BUCK. Today the United States' space enterprise faces a wide spectrum threats from interference with the signals that carry information from orbit to end users, such as GPS signals or satellite communications, to the use of directed energy against our space-based ISR capability, to the development of kinetic options against on-orbit platforms . . . these threats continue to proliferate. To address these threats, we continually seek ways to make our architectures more resilient and able our space-based systems to 'operate through' any contested, denied, or operationally limited environment. From a more 'whole of government' approach, JFCC SPACE continues strengthen relationships with the interagency and mature our international partnerships with like-minded, space-faring nations toward increasing overall deterrence by demonstrating that an attack on a U.S. space capability is an attack on global stability and that assured access to space by all is a global concern.

Mr. ROGERS. The growing congestion in the space environment, including the increasing number of small satellites such as cubesats, has raised concerns about the potential for increased space debris. What is DOD doing to track objects such as cubesats, minimize the possibility of collision among its space assets, and improve tracking of space debris?

General BUCK. To track; and improve tracking of debris:

DOD employs the global Space Surveillance Network (SSN) to track objects in all orbital regimes and receives on average over 400,000 observations each day. The SSN is a mix of optical, mechanical radar, phased array radar, and space-based assets which provide the backbone of the U.S. Satellite Catalog.

The SSN's day to day operations are managed from the JFCC SPACE's Joint Space Operations Center (JSpOC) that optimizes these resources to sufficiently track and report high interest events such as human spaceflight, potential adversary actions, launches, and reentries, in addition to normal space flight activities. The observations on these high interest events and objects are transmitted to the JSpOC for analysis and used to build the total space situational awareness (SSA) picture by layering positional information with additional sources such as operator provided ephemeris or intelligence.

To improve overall tracking, a notable upgrade is the new Space Fence, scheduled for operations in 2018, which I believe is the most-significant improvement to low- and medium-earth orbit SSA capabilities in decades. By some estimates, the Space Fence will improve our catalog awareness from 23,000 to over 200,000 tracked objects. The delivery of the Space Fence will provide JFCC SPACE greater coverage for detection of near-earth objects as well as improved ability to detect unforeseen or unannounced space events such as breakups and maneuvers.

Cubesat Tracking:

Cubesats are a unique challenge, but one that the DOD has actively engaged with industry on for a number of years. Partnerships with academia, NASA, and other cubesat launchers has resulted in a large number of operators engaging with JSpOC very early in their constellation planning to ensure they take DOD tracking techniques into account when they deploy their objects. Ultimately, we would like to see more active tracking techniques added to these objects to improve responsiveness in identification.

To minimize collisions:

Collision mitigation is accomplished by JFCC SPACE through the JSpOC by comparing the predictive locations of orbiting objects to assess if there is a risk of close approach and, if so, what the predicted miss distance is at the time of closest approach. This process is referred to as Conjunction Assessment (CA). Through our relationships with over 600 civil, commercial, and military missions worldwide, we issue over 3,000 notifications daily to these partners advising of possible close approaches. Not all notifications are actionable, but for those messages in which the operator decides to maneuver, we screen their proposed maneuver plan to ensure they do not create new or increased risk to their satellite or others.

The CA mission continues to evolve. The JSpOC screens all active payloads against all tracked objects multiple times a day. Current screening data not only includes our SSN data but also includes ephemeris and future maneuver plans from many operators. We are constantly innovating new techniques, with the collaboration of other military organizations, NASA, and commercial partners. With the implementation of the JSpOC Mission System (JMS) Service Pack 2 this year and new

sensors like the Space Fence, JFCC SPACE's ability to detect and warn of potential collisions will be improved.

Mr. ROGERS. What is the plan for the Joint Interagency Combined Space Operations Center (JICSPOC) going forward, and how does this compare with the plan for the Joint Space Operations Center (JSPOC)?

General BUCK. Although there has not been a final decision on the long-term mission of the JICSpOC, we have already learned much from its first three experiments and are using the information to determine the future construct for unity of effort across the USG to preserve our Nation's access to space and to provide seamless space-based capabilities for our forces. We will continue to use the information coming out of the JICSpOC to plan for emerging and advanced space threats and will leverage it to provide vital information, capabilities and effects for national leadership, allies and partners, and the Joint Force. Like the JSpOC, JFCC SPACE's primary command and control operations center, the JICSpOC will be assigned to JFCC SPACE; the two centers will work in unison to ensure space-based capabilities are delivered to our forces and to protect and defend the space domain.

Mr. ROGERS. Cloud characterization and theater weather imagery are the top two most important certified requirements regarding space-based weather collection. What are the risks if these warfighter requirements are not met?

General BUCK. Accurate characterization of cloud tops is critical to missile detection, missile warning and intelligence collection and analysis. Insufficient space-based weather collection over theaters of operation will negatively affect our ability to accurately monitor and subsequently forecast thunderstorms, icing, turbulence, tropical cyclones and other environmental factors affecting force maneuver and mission execution.

Specific effects include:

- Space-based and airborne intelligence, surveillance and reconnaissance (ISR), required for monitoring enemy force disposition/employment and targeting, require accurate cloud characterization for planners to predict the best time and locations for electro-optical/infrared (EO/IR) coverage.
- Overhead persistent infrared (OPIR) collections, critical for strategic and theater missile warning, require accurate cloud characterization and theater weather information for collection, monitoring and characterization.
- Successful force employment to include planning, maneuver, weapon selection, and execution timing rely on accurate weather forecasts enabled through persistent theater weather imagery.
- Time sensitive operations such as search & rescue and medical evacuation require timely and accurate weather forecasts.

Mr. ROGERS. What affect will disaggregation of nuclear and non-nuclear missions have on an adversary's risk calculus regarding attacking U.S. space assets? Will it lead to less complicated and/or lower the threshold for attacking space systems supporting the United States' ability to project power with non-nuclear forces? If so, are you concerned that disaggregation could weaken deterrence and foster crisis instability?

General BUCK. Disaggregation of space-based missions complicates a potential adversary's risk calculus and provides a level of resilience to our space based capabilities. Disaggregation should be investigated from both mission and orbital regime perspectives. Using multiple orbital regimes for space based missions (low earth orbit, medium earth orbit, geosynchronous earth orbit and highly elliptical orbits) complicates an adversary's decision calculus. Focusing solely on mission disaggregation could enable an adversary to assume non-nuclear targeting remains below any threshold for escalating into multi-theater armed conflict. A balanced approach to disaggregation increases overall resilience, avoids any implication that some space capabilities can be targeted with fewer consequences, and, as such, offers a greater potential for deterrence and stability.

Mr. ROGERS. Do you support establishing so-called "red lines" through declaratory policy statements to refrain from deliberate interference with nuclear command, control, and communications or early warning space systems?

General BUCK. The United States is committed to reinforcing positive norms of behavior to ensure the continued peaceful use of space for all responsible nations. The establishment of "red lines" as posed in your question is a policy vice military decision. The political decision on declaratory policy will likely need to weigh the loss in flexibility with respect to an ever changing geopolitical environment against any potential deterrence value from such a declaration. That said, if such declarations are made, JFCC SPACE is prepared to execute any mission received should an adversary decide to act in abeyance of those declarations.

Mr. ROGERS. Do you believe that Russia or China will honor international norms to refrain from deliberate interference with nuclear command, control, and commu-

nications or early warning space systems in the event of crisis or conflict with the United States?

General BUCK. I believe that Russia and China will honor international norms (and in Russia's case, its specific obligations under the New START treaty) as long as they perceive it as in their national interests to do so. While neither seek nuclear conflict with the United States, it is prudent to consider that, if either regime feels threatened, neither is likely to remove options from consideration. That said, the degree of international cohesiveness against aggression in the space domain will be a part of both Russian and Chinese decision calculus. To convince them to continue to honor those norms, we need to employ a well-rounded strategy of deterrence to include strong partnerships with like-minded space faring nations.

Mr. ROGERS. What is the current state of the space acquisition workforce with regard to numbers of acquisition professionals and their acquisition management expertise? If there are shortcomings in the acquisition workforce, what is being done about them? What efforts are underway to enhance development of the space acquisition workforce?

Mr. CALVELLI. NRO has a robust complement of acquisition professionals, including personnel from the CIA's Directorate of Science & Technology (DS&T) Office of Space Reconnaissance (OSR), Active Duty Air Force, Navy, and Army personnel, and NRO's new DOD Cadre workforce. While the entirety of NRO's space acquisition workforce is not "formally" designated, this diverse set of professionals is focused on ensuring every NRO space acquisition is successfully delivered on time and on budget. With respect to training and expertise, personnel occupying acquisition positions are required to pursue appropriate certifications through the Defense Acquisition University (DAU) in accordance with DOD regulations and the Defense Acquisition Workforce Improvement Act (DAWIA). Personnel assigned to the NRO from other agencies are required to comply with their home agency certification and training requirements, in addition to taking courses offered by the NRO's Acquisition Center of Excellence (ACE). Additionally, CIA officers can also take available CIA-specific acquisition courses. In addition to other Intelligence Community detailees, the CIA does not specifically code their billets as "acquisition." However, the CIA's DS&T Office of Space Reconnaissance (OSR) was formally established in 2014 to provide CIA officers a career path focused on space and space-related acquisitions. The number of CIA personnel assigned to the NRO is classified and will be provided separately to your staff. At this time, I do not believe there are shortcomings in the NRO acquisition workforce. Those acquisition coded positions not currently occupied by appropriately certified personnel are monitored on a monthly basis to assess their status and track their certification progress. The NRO continues to receive tremendous support from its military service and intelligence community partners. In addition to Defense Acquisition University (DAU) training, the NRO has numerous other avenues available to personnel to broaden and deepen their acquisition skillset both formally and informally. These include the NRO Acquisition Center of Excellence (offering NRO-unique acquisition training); informal training/experiences; advanced education (University of Maryland and Virginia Tech on-site Masters programs); professional certifications (Naval Post Graduate School, etc.), and other programs within the DOD or the Intelligence Community (National Defense University, National Intelligence University, etc.). Additionally, Central Intelligence Agency (CIA) personnel seeking CIA Contracting Officer Technical Representative (COTR) certification may take CIA-specific courses, or substitute NRO ACE courses for CIA COTR Acquisition Training I (CAT–I) and COTR Acquisition Training II (CAT–II).

Mr. ROGERS. Please explain how implementation of the Space Enterprise Vision will improve the affordability, resilience, and capability of the future national security space architecture.

Mr. CALVELLI. The Space Enterprise Vision (SEV) describes a shared vision between the National Reconnaissance Office and Air Force Space Command (AFSPC). It is a resiliency strategy that achieves robustness through a layered defense-in-depth integrated with architectural agility designed to promote threat denial and asymmetric cost imposition in combination with decision superiority. The vision developed jointly between the NRO and AFSPC is responsive to a broad spectrum of disruptive counter space threats in all contested regimes including space, ground, and cyber. While this vision does not call for a shared single architecture, it describes a coordinated approach across all space mission areas, coupling the delivery of space mission effects to policy makers, the warfighters, and the Intelligence Community with the ability to protect and defend space capabilities against emerging threats. Core elements include persistent situational awareness, protection of strategic-enabling capabilities, and agile operations within a balanced force structure optimized to preserve mission and enforce a deterrence posture against adversaries.

The strategy builds resiliency through an enterprise approach that leverages a synergistic strength created by mutually supporting capabilities, effects, and tactics.

Mr. ROGERS. Is the Air Force Space Command and the National Reconnaissance Office taking different approaches to improve the resilience and assurance of the national security space architecture? If so, why?

Mr. CALVELLI. Although the orbital disposition and mission composition of the NRO and Air Force space architectures are different, they are complementary and the central tenets of achieving resiliency are largely the same. Both organizations are evaluating the appropriate mixture of resiliency insertion options to include hosted payloads, off-boarding, path diversity, and disaggregation to best accomplish the breadth of title 10 and title 50 missions in a contested environment. Varying approaches to achieving balance between resiliency and mission assurance at the platform and constellation level are being pursued by the NRO and Air Force Space Command depending on mission parameters. These systems exhibit varying degrees of interoperability within the national security space architecture to achieve the overall performance and resiliency goals prescribed for the SEV. In addition, both organizations benefit from distributed indications and warning systems working cooperatively to avoid surprise and to provide timely attribution of threats for effective mitigation and operate-through. Integrated decision support tools such as those demonstrated in the JICSpOC will combine data flows derived collectively from multiple sensor perspectives to improve threat prediction confidence, prioritize alerts, and orchestrate responses for space control at the leading edge of threat engagement.

QUESTIONS SUBMITTED BY MR. COOPER

Mr. COOPER. How does DOD's approach to phasing out reliance on Russian engines best ensure rapid and reliable access to space? What would the impact be of restricting funding to just an engine? Would this be the optimal way forward to gain assured access to space in the near and long-terms?

General HYTEN. The optimal path to assured access to space is by initiating public private partnerships for the development of commercial launch systems that also meet the requirements to provide national security space (NSS) launch services. Investment in industry's launch services improves assured access to space for multiple reasons. First, the DOD has insight into the development of new or upgraded launch systems and can work directly with industry to manage the integration of NSS requirements. Second, investment increases the likelihood of meeting stressing NSS launch requirements using launch systems that are also commercially viable. Commercially viable launch service providers share the fixed costs of commercial launch services across commercial and Government customers, reducing the overall cost to the Government even if NSS missions cost more to meet the more strenuous launch requirements. Engine development alone does not guarantee a launch solution unless a launch service provider uses the engine and could result in billions in taxpayer funds wasted if the Government developed engine is not used by a launch provider. In addition, implementing a "drop in replacement" without significantly redesigning the launch vehicle drives inefficiencies that may make the overall launch vehicle more expensive because it may require more fuel or strap-on solids to take the satellites to the required orbits. Thus, the best way near- and long-term to obtain the required performance at a reasonable cost is to design the launch vehicle and engine together. If authorized in FY17, the Air Force will start investing in launch services, which will result in the development of launch systems including completing the rocket propulsion systems, and any required launch system infrastructure. Shared investment with launch providers and competition for launch services is a feasible and cost-effective approach. This type of approach was successfully demonstrated on: 1) Original EELV program, 2) NASA Commercial Orbital Transportation Services (COTS), and 3) NASA Commercial Crew.

Mr. COOPER. Commercial industry, including SpaceX, Orbital-ATK, ULA and Blue Origin have are planning to make or use a methane engine in their launch vehicle. If this type of engine is not deemed too risky for a large part of the industry (assuming it is tested and certified), should it be considered too risky for government?

General HYTEN. The Department of Defense strategy is to invest in a commercial launch service provider solution. Multiple providers are considering methane engines. If an engine is acceptable in terms of risk for the industry and it meets all our National Security Space (NSS) requirements for launch vehicle certification, it would be appropriate for NSS launches.

In addition, the DOD has initiated engine studies as part of the effort to reduce the biggest risks to engine development, including the use of methane as a fuel.

These results are already being shared with industry to increase the chances of engine development success. While there is much interest in an oxygen rich staged combustion (ORSC) methane engine, the difficulty in developing one cannot be dependably characterized yet. With little American experience with methane and kerosene ORSC engines, there are many opinions, and no solid evidence regarding the pros or cons of ORSC methane engines. For this reason, we are pursuing both methane and kerosene engine technologies until they are demonstrated.

Mr. COOPER. How much funding is there in FY17 to enhance resilience in space?

General HYTEN. The current U.S. space enterprise is not resilient enough to survive all threats that extend into space. The entire FY17 Presidents Budget for the Air Force Space portfolio directly or indirectly supports resilient capabilities, agile defense, reconstitution, and robust Command, Control and Communications (C3) to provide Space Superiority. All systems we are requesting in the budget are being designed to improve the resiliency of the space enterprise. Examples of these efforts include investments in a more standardized, agile, and cyber-secure enterprise ground architecture; improved Space Situational Awareness capabilities; battle management and command and control experimentation; and a range of development initiatives focused on resilience of the Air Force Space portfolio of capabilities.

Mr. COOPER. Absent the launch of DMSP–20, beyond 2020 (estimated lifespan of DMSP–19), how does the Air Force plan to provide the capabilities DMSP–20 would have provided? With DMSP–19 failing recently, would there now be renewed utility to launch DMSP–20?

General HYTEN. Consistent with Joint Requirements Council (JROC) validation of the Space-Based Environmental Monitoring Analysis of Alternatives (JROCM 092–14, dated 3 September 2014) the Department of Defense (DOD) has been working to address microwave imaging and space weather satellite anomaly assessment capabilities with a DOD materiel solution acquisition, the Weather System Follow-on. The JROC directed leveraging civil/international partner capabilities, as well as possible non-materiel solution options, for the remaining space weather and electro optical/infrared sensing needs (such as cloud characterization and theater weather imagery). Per Congressional direction in the FY15 & FY16 National Defense Authorization Acts (NDAA), the FY16 Consolidated Appropriations Act, and in coordination with stakeholders, the DMSP Program Executive Officer and Milestone Decision Authority (Lt Gen Greaves) signed a Termination Acquisition Decision Memorandum on 30 December 2015. The Termination ADM initiates a set of activities and specific tasks defined in the Federal Acquisition Regulation. Specific timelines are specified in the FAR for completion of those efforts and an integrated program schedule has been developed to manage those efforts, resulting in space vehicle disposition by 20 December, 2016. While the implementation of termination is underway, Lt Gen Greaves directed the program office to take no irreversible action for the moment to allow the AF, DOD, and Congress an opportunity to evaluate the utility of launching DMSP–20. Bottom line is that the Air Force is executing the termination plan per the FAR and has until 1 June 2016 to make a decision on DMSP 20 without affecting the 20 December 2016 mandate.

Mr. COOPER. Are we willing and sufficiently prepared to be able to rely on allied space launch capability in an emergency case where U.S. launch providers would not be available?

General HYTEN. The National Space Transportation Policy states: "United States Government payloads shall be launched on vehicles manufactured in the United States unless an exemption is coordinated by the Assistant to the President and National Security Advisor and the Assistant to the President for Science and Technology and Director of the Office of Science and Technology Policy through an interagency process." In addition to this, 51 USC 50131 states, "...the Federal Government shall acquire space transportation services from United States commercial providers whenever such services are required in the course of its activities. To the maximum extent practicable, the Federal Government shall plan missions to accommodate the space transportation services capabilities of United States commercial providers."

It may be necessary in an emergency to use allied launch services, but each of the NSS satellite program offices and customers (AFSPC and NRO) have specific detailed technical interface and security requirements that would have to be met and accommodated by the allied launch service, which would be difficult to achieve on short notice. The Air Force and The Aerospace Corporation conducted a very general study in late 2013 which found nothing to preclude an allied launch provider, Arianespace, from potentially launching NSS payloads. The Air Force plans to conduct a more in-depth study/assessment during 2016 in collaboration with Arianespace. This study will focus on collecting data and a detailed assessment of Arianespace launch vehicles as a backup capability for NSS missions. When the study is

complete, we will have a much better idea of what it will take (time, resources, and technical resources) to launch NSS payloads using allied launch services. If it is determined that launch of a mission payload on a foreign launch service is in the national security interests of the U.S. due to the unavailability of a domestic launch capability, the Air Force would comply with the National Space Transportation Policy exemption guidelines.

Mr. COOPER. Last year during the Strategic Forces Subcommittee launch hearing, both SpaceX and ULA testified that they did not require any government funds to develop a new engine. What are the incentives for private industry to develop a new engine and what is the value of planned expenditures by DOD that these companies would compete for in the national security market once they have developed an engine? What is the right balance in a public/private partnership in terms of funding a new engine?

Mr. LOVERRO. The Department's Evolved Expendable Launch Vehicle (EELV) Rocket Propulsion System (RPS) and Launch Services Investment (LSI) programs represent an integrated approach in which the Department partners with industry to develop not only domestically designed and manufactured liquid- and solid-fuel based propulsion systems, but more importantly, new and improved launch services capabilities. The Department is funding these activities in an effort to ensure that current and future launch service providers focus on developing systems that meet all of the Department's requirements, not just those driven by the commercial market place. The Department's requirements are typically much more demanding than those of commercial customers.

Because of the Department's innovative use of Other Transaction Authority (OTA) on the RPS program, industry is required, by statute, to provide at least one-third of the funding for the project. The Department is encouraging our OTA industry partners to contribute at a level higher than one-third. Even at a one-third contribution, however, the Department is receiving an excellent return on its RPS investments. The ultimate incentives for those investments is clearly access to the future National Security launch market, which CAPE estimated at $80B in 2013.

Mr. COOPER. How can we better take advantage of emerging commercial capabilities, whether it be imagery or space situational awareness?

Mr. LOVERRO. As I testified in my hearing and in response to HASCSF–03–12, leveraging U.S. commercial entrepreneurial developments is a center piece of our overall space strategy. From a policy perspective, we have focused on efforts to eliminate unnecessary and outdated barriers to commercial innovation while still assuring national security protections. From an architectural basis, we are carefully studying whether we can disaggregate previously aggregated strategic and tactical space systems to allow greater utilization of commercial capability to meet those tactical needs. Most challenging are the acquisition and business impediments to utilizing commercial space capabilities, which we are trying to address with innovative business arrangements such as the commercial SatCom Pathfinder activities and more intensive use of other transaction authorities.

In the specific area of remote sensing and commercial SSA, we have two main efforts. For remote sensing, NGA has built a strategy for commercial utilization which they are rapidly pursuing. On the SSA side, Air Force Space Command and STRATCOM have embraced the Commercial Space Operations Center (ComSpoc from AGI) as a foundational element within the JICSPoC experiment to see how it might address current shortfalls.

We welcome and embrace these emerging innovations; however, rather than focusing on outdated policy barriers, the Department must improve its ability to exploit innovative approaches while maintaining national security.

Mr. COOPER. How does DOD's approach to phasing out reliance on Russian engines best ensure rapid and reliable access to space? What would the impact be of restricting funding to just an engine? Would this be the optimal way forward to gain assured access to space in the near and long-terms?

Mr. WEATHERINGTON. The Department continues to be dedicated to ending use of the Russian manufactured RD–180 engine as soon as reasonably possible, but still believes that access to the RD–180 while transitioning to new and improved launch service capabilities is the optimal way forward to meet statutory and Department policy requirements for assured access to space in both the near and long term. The Department also continues to focus on the development of new and improved launch service capabilities as this approach allows launch service providers to perform the design and optimization trades necessary to offer commercially viable launch services, using domestic propulsion systems, capable of meeting the Department's space launch requirements. Any new engine still has to be incorporated into a launch vehicle. The Department does not want to be in a position where significant resources have been expended on an engine and no commercial provider has built the nec-

essary vehicle to use that engine. Restricting funding to engine development only would likely drive the development of an engine designed for a specific rocket, and at least initially, provide an advantage to a single launch service provider.

Mr. COOPER. Last year during the Strategic Forces Subcommittee launch hearing, both SpaceX and ULA testified that they did not require any government funds to develop a new engine. What are the incentives for private industry to develop a new engine and what is the value of planned expenditures by DOD that these companies would compete for in the national security market once they have developed an engine? What is the right balance in a public/private partnership in terms of funding a new engine?

Mr. WEATHERINGTON. The Department's long-term goal is to field new and improved launch service capabilities that will result in two or more commercially viable launch service providers utilizing domestically manufactured propulsion systems, that can support National Security Space missions to all 8 Evolved Expendable Launch Vehicle (EELV) reference orbits.

The Department's EELV Rocket Propulsion System (RPS) and Launch Services Investment programs are designed to incentivize industry to develop not only domestically designed and manufactured liquid and solid fuel based propulsion systems, but more importantly, new and improved launch services capabilities. The Department is funding these activities in an effort to ensure current and future launch service providers focus on developing systems that meet all of the Department's requirements, that being able to place missions to all 8 EELV reference orbits, and not just those driven by the commercial market place. The Department's requirements are typically much more demanding than those of commercial customers.

The Department is utilizing innovative use of Other Transaction Authority (OTA) agreements on the RPS program. The OTA agreements awarded by the Air Force require industry performers, by statute, to provide at least one third of the funding for the project. The Department is encouraging our OTA industry partners to contribute at a higher percentage. Even at a one third contribution, the Department is receiving an excellent return on its RPS investments. Additionally, a launch service provider who develops a system that meets the Department's requirements will have the opportunity to bid on up to 23 Air Force missions valued up to $8B over the FYDP.

Mr. COOPER. Commercial industry, including SpaceX, Orbital-ATK, ULA and Blue Origin have are planning to make or use a methane engine in their launch vehicle. If this type of engine is not deemed too risky for a large part of the industry (assuming it is tested and certified), should it be considered too risky for government?

Mr. WEATHERINGTON. The Department does not deem a methane based engine as too risky for government use based on current knowledge. To date, there has not been a methane based engine developed, tested, and certified of the size necessary to power to an Evolved Expendable Launch Vehicle (EELV) class launch vehicle. The Blue Origin BE–4 engine, currently under development and planned for possible use in the ULA next-generation Vulcan launch vehicle, is a methane based engine designed to use an oxygen-rich staged combustion (ORSC) engine cycle, similar to that used by the RD–180. While there has been international manufacturing of ORSC engines for many years, U.S industry has never designed, manufactured, and fielded an ORSC engine, either methane or kerosene based, capable of powering an EELV class launch vehicle. In order to reduce program risk and build U.S. manufacturing expertise in the ORSC area, the Department recently awarded four Other Transaction Authority agreements to fund multiple liquid and solid propulsion system development approaches as part of the EELV Rocket Propulsion System program.

Mr. COOPER. Has the advent of new entrants in national security space launch benefited national security and the taxpayers? On what basis do you make this assessment?

Mr. WEATHERINGTON. The emergence of new entrants provides the Department with an additional path to space, for some of our missions, which enables us to preserve assured access to space and benefits national security. The Department recently announced award of the GPSIII–2 launch service; this award achieves a balance between mission success, meeting operational needs, lowering launch costs, and reintroducing competition for National Security Space missions. The Air Force expects to compete three more launch services in FY 2016. The Department will be better able to quantify the cost reduction benefit to the taxpayer after these contracts have been awarded. While the cost reductions associated with competition are extremely important, ensuring that all certified EELV providers and potential EELV new entrants meet the Department's rigorous mission assurance standards and are able to reliably fly to all eight EELV mission orbits remains our top priority.

Mr. COOPER. The request includes $30M for pathfinder activities to improve the acquisition of commercial satellite communications. There is support to bring additional commercial capabilities to DOD, better value to taxpayers and new approaches to acquiring COMSATCOM. However, there are questions about the extent to which the Air Force is leveraging the latest technology to its full capability, and whether it is heeding the direction in the FY16 NDAA which required a pilot program to demonstrate orders-of-magnitude improvements in capability and capacity. Why are investments in this type of pathfinder not planned until the 2020s instead of in the next few years?

Mr. WEATHERINGTON. The Department's wideband satellite communication (SATCOM) pathfinder activities have already started and include five Air Force and five Defense Information Systems Agency (DISA) pathfinders. The first four DISA and the first Air Force pathfinder activities have either been completed or are providing useful data. The last DISA and the second Air Force pathfinder efforts should be on contract by the end of FY 2016. The FY 2017 President's Budget requested funds for the Air Force's last three pathfinder efforts, which should be awarded in FY 2017 through FY 2019. These pathfinder activities are part of the pilot program for providing a cost-effective and strategic method to acquire commercial SATCOM services directed by the FY 2016 NDAA.

Mr. COOPER. Are we willing and sufficiently prepared to be able to rely on allied space launch capability in an emergency case where U.S. launch providers would not be available?

Mr. WEATHERINGTON. The Department is required by statute and policy to fly National Security Space (NSS) payloads on U.S. manufactured launch vehicles. While there has been some preliminary investigation into the use of the Ariane V vehicle for use by NSS payloads, a significant amount of follow-up work would be required before any definitive conclusions could be made. In the case of a national emergency, this analysis could become a priority, but it is difficult to imagine a situation where the entire U.S space launch capability was grounded for a period long enough to allow the reintegration of an NSS payload to a new launch vehicle. The first time integration of a satellite onto a launch vehicle is a process that typically takes 2 to 3 years.

Finally, it should be noted that Ariane V has not demonstrated the capability to fly to all eight of the NSS required orbits.

The FY 2016 NDAA Sec. 1607, Joint Explanatory Statement (JES) included a congressional briefing requirement for an executable backup plan for assured access to space. The JES directs the Department to evaluate options for an executable backup plan for assured access to space that maintains competition as feasible. The Air Force is in the initial rounds of coordinating the draft briefing and plans to deliver it to the Congressional Defense Committees by the end of July 2016.

Mr. COOPER. How can we better take advantage of emerging commercial capabilities, whether it be imagery or space situational awareness?

Mr. CARDILLO. [The information referred to is classified and retained in the committee files.]

Mr. COOPER. How have you leveraged commercial capabilities and open source analysis to augment traditional collection? Do you need additional authorities for this?

Mr. CARDILLO. [The information referred to is classified and retained in the committee files.]

Mr. COOPER. How much funding is there in FY17 to enhance resilience in space?

Mr. CALVELLI. A classified, detailed breakdown of NRO's funding for resiliency will be provided separately via secure means.

QUESTIONS SUBMITTED BY MR. LAMBORN

Mr. LAMBORN. Last Fall, the Air Force released its "Future Operating Concept", a strategic vision for where the Air Force wants to go in the next 20 years. It contains several thought-provoking vignettes. One vignette, titled "Space Control Challenged" envisions a Multi-Domain Operations Center which combines and integrates air, space, and cyberspace information and operations. At the MDOC, an Air Force Captain receives warning of an imminent ground-based laser attack on one of our commercial imagery satellites, and then uses big data fusion, analytics and simulation to select an offense cyber response. As the battle continues, he is able to have real-time situational awareness and command and control to fight the war in space. In another vignette, called "Satellites On-Demand", an F–35 pilot responds to an adversary's offensive degradation of U.S. space capabilities by launching an on-demand rapid reconstitution satellite cluster. Once the F–35 releases the satellite clus-

ter at high altitude, a modular satellite booster propels the cluster into orbit, where it deploys into a dispersed network formation of micro-sat's complete with electromagnetic-spectrum measures, which complicates adversary space-control actions. The cluster is thus able to focus its sensors on an area of interest and supports a strike package inbound to attack targets in enemy territory. My question is, what's being done to make this vision a reality across the national security enterprise? How can we work with you to help you achieve your vision? Also, given that this represents where the Air Force would like to be in 2035, do we really have to wait 20 years to see these concepts become a reality? What's stopping us from doing it faster?

General HYTEN. JICSpOC experimentation, the Space Mission Force (SMF), and development of a threat-informed Space Enterprise Vision (SEV) are the foundational elements to implement the Air Force strategic vision described in the "Future Operating Concept." These initiatives will enable our space mission forces to more effectively respond to counterspace threats, enhance space crew readiness with advanced training and tools, integrate space into agile, multi-domain operations, and increase the resilience of the space enterprise.

Mr. LAMBORN. How can we help you achieve your vision?

General HYTEN. Consistent funding over time; more specifically, your continued support toward experimentation activities, embodied in the current JICSpOC effort, is extremely important. The JICSpOC will not only inform us how to better operate with current capabilities, but will also identify any materiel gaps requiring additional acquisition and funding requirements.

Current gap assessments identify the need for a fully funded, joint, and combined Space Battle Management Command, Control, and Communications (BMC3) system to assure continued access to space for the U.S. and its partners and allies. Another key initiative is our shift toward a Space Mission Force as we advance the skillsets of our space crews to operate in a contested environment. Finally, congressional support toward the Enterprise Ground Services initiative is necessary as we move to a common interface environment for our Airmen so they may focus on improved mission and warfighter effects vice routine tasks.

While the Bipartisan Budget Act provides much needed stability and predictability, we would reiterate the Secretary of the Air Force's call for a permanent lift to sequestration. Ultimately, continued support for the FY17 Air Force budget request is an important step toward arresting the erosion of our competitive advantage.

Mr. LAMBORN. Also, given that this represents where the Air Force would like to be in 2035, do we really have to wait 20 years to see these concepts become a reality?

General HYTEN. Given today's space and cyberspace threats and projected future threats, we cannot afford to wait 20 years. Some nations are aggressively expanding their pursuit of counterspace technologies now. They are adapting quickly to hold U.S. space and cyberspace capabilities at risk. It is imperative that we respond more rapidly to changing threats in space.

Mr. LAMBORN. What's stopping us from doing it faster?"

General HYTEN. The challenge is significant, and the largest barrier to faster progress is a lack of mature technology. We are actively pursuing technologies in support of the Air Force future concept, such as development of a shared common operating picture that will allow automated information sharing and integration across multiple domains and security levels. Development of this technology is a priority. Further, we are engaged in interagency and international forums, exercises, and experiments to explore synergistic efforts/technologies that may address shared and pervasive needs in the space arena. This investment of time also allows examination of potential solution sets, current operational limitations, and capture of mature requirements needed to develop the requisite capabilities and highly-trained forces needed to fulfill the vision and accelerate concept implementation. Inculcating greater threat awareness into a space force that has traditionally operated platforms in the relatively safe, benign environment of space will also take time, but we are tackling that with the Space Mission Force initiative.

Mr. LAMBORN. Can you please provide some more detail about your Space Training Transformation Initiative? During the four-month periods when space operators are "off-crew", where, and how, does advanced training take place?

General HYTEN. The Space Training Transformation (STT) Initiative implements guidance from CORONA Top 2012 and the Space Professional Functional Authority to develop and implement a more robust Air Education and Training Command (AETC) Officer and Enlisted Undergraduate Space Training (UST) expanding the course from 33 to 76 training days. STT also transitions the responsibility for space weapon system specific training from AETC to Air Force Space Command (AFSPC).

Through the realignment of resources and organizational responsibilities, STT functions will allow for rapid unit training content updates and enable the most cost-effective use of Air Force resources while increasing technical understanding of the space domain.

The second part of the question is part of our separate, but related, Space Mission Force (SMF)/Ready Spacecrew Program (RSP) Initiative. During the four-month periods when space operators are "off-crew", they will receive advanced training at their local units/wings. Advanced training is the set of formal training requirements, beyond weapon system qualification and continuation training, to advance the skills required to ensure mission accomplishment in a contested, degraded and operationally-limited (CDO) environment. Advanced training events will include classroom, simulator and exercise sessions focusing on CDO challenges, defensive tactics, techniques and procedures (TTPs), system and operations integration, and mission planning and debriefing for the current and future threat environment. Advanced training events will push operators to their limits and drive them to improve and discover new and better ways to conduct operations.

Mr. LAMBORN. Last Fall, the Air Force released its "Future Operating Concept", a strategic vision for where the Air Force wants to go in the next 20 years. It contains several thought-provoking vignettes. One vignette, titled "Space Control Challenged" envisions a Multi-Domain Operations Center which combines and integrates air, space, and cyberspace information and operations. At the MDOC, an Air Force Captain receives warning of an imminent ground-based laser attack on one of our commercial imagery satellites, and then uses big data fusion, analytics and simulation to select an offense cyber response. As the battle continues, he is able to have real-time situational awareness and command and control to fight the war in space. In another vignette, called "Satellites On-Demand", an F–35 pilot responds to an adversary's offensive degradation of U.S. space capabilities by launching an on-demand rapid reconstitution satellite cluster. Once the F–35 releases the satellite cluster at high altitude, a modular satellite booster propels the cluster into orbit, where it deploys into a dispersed network formation of micro-sat's complete with electromagnetic-spectrum measures, which complicates adversary space-control actions. The cluster is thus able to focus its sensors on an area of interest and supports a strike package inbound to attack targets in enemy territory. My question is, what's being done to make this vision a reality across the national security enterprise? How can we work with you to help you achieve your vision? Also, given that this represents where the Air Force would like to be in 2035, do we really have to wait 20 years to see these concepts become a reality? What's stopping us from doing it faster?

Mr. LOVERRO. In 2015, the Air Force published the Air Force Strategy, "Call to the Future, the Air Force Future Operating Concept," which provides an explanation of a notional end-state; and the Strategic Master Plan (SMP), which includes a 20-year roadmap to achieve the Air Force Future Operating Concept (AFFOC) end-state. The SMP has five vectors (21st Century Deterrence, Global Integrated Intelligence, Surveillance, and Reconnaissance (ISR), Multi-Domain Approach, Full-Spectrum Capable, High-End Focused Force, and Game-Changing Technologies); these vectors represent the path to get to the AFFOC end-state. Implementing the strategy will be a long process that crosses all of the core missions and every organization and that uses all major corporate processes including resourcing, manpower, acquisition, training and education, and technology development. The Under Secretary of the Air Force and the Vice Chief of Staff of the Air Force have appointed 3-star "Champions" for each of the vectors to provide the strategic leadership and synchronize the tactical tasks associated with implementing the SMP Goals and associated Objectives. They are using the Air Force Council as the forum to institutionalize senior leader dialogue and the strategic focus that will be required to implement the Air Force strategy.

From an OSD perspective, we view these vectors as important glide-paths to future warfighting concepts, but we all recognize that bold vision such as these will mature and evolve over time and that it may not be technologically possible to achieve those goals sooner than the Air Force estimates.

Mr. LAMBORN. In establishing the Principal DOD Advisor for Space position, DEPSECDEF noted that the Executive Agent for Space construct did not work as planned because it was essentially a coordinating body with little authority. What reason is there to believe that the PDSA will not suffer the same fate, especially when it does not have any budget authority? What, if any, are the current challenges with the PDSA structure?

Mr. LOVERRO. The Deputy Secretary has designated the Secretary of the Air Force as the Principal DOD Space Advisor (PDSA) and has expanded her authorities and responsibilities to provide independent assessments and recommendations to the

Secretary of Defense and the Deputies Management Action Group regarding space programs, budgets, and activities.

This is an important step to improve governance of DOD space programs, and the Department believes that the PDSA has sufficient authority to accomplish the task. The Deputy Secretary has been clear that we will evaluate the effectiveness of the PDSA over time and, if necessary, adjust authorities to fully meet the intent of the PDSA structure.

Mr. LAMBORN. Last Fall, the Air Force released its "Future Operating Concept", a strategic vision for where the Air Force wants to go in the next 20 years. It contains several thought-provoking vignettes. One vignette, titled "Space Control Challenged" envisions a Multi-Domain Operations Center which combines and integrates air, space, and cyberspace information and operations. At the MDOC, an Air Force Captain receives warning of an imminent ground-based laser attack on one of our commercial imagery satellites, and then uses big data fusion, analytics and simulation to select an offense cyber response. As the battle continues, he is able to have real-time situational awareness and command and control to fight the war in space. In another vignette, called "Satellites On-Demand", an F–35 pilot responds to an adversary's offensive degradation of U.S. space capabilities by launching an on-demand rapid reconstitution satellite cluster. Once the F–35 releases the satellite cluster at high altitude, a modular satellite booster propels the cluster into orbit, where it deploys into a dispersed network formation of micro-sat's complete with electromagnetic-spectrum measures, which complicates adversary space-control actions. The cluster is thus able to focus its sensors on an area of interest and supports a strike package inbound to attack targets in enemy territory. My question is, what's being done to make this vision a reality across the national security enterprise? How can we work with you to help you achieve your vision? Also, given that this represents where the Air Force would like to be in 2035, do we really have to wait 20 years to see these concepts become a reality? What's stopping us from doing it faster?

Mr. WEATHERINGTON. The Department's efforts to transition to an operationally agile, fully integrated, multi-domain force are being supported by on-going technology development, experimentation, wargaming, and use of open architecture and network centric engineering principles. We are developing network enabled command and control systems (i.e., Air Operations Center, Joint Space Operations Center Mission System) that incorporate open architecture principles to enable interoperability and operational flexibility. In parallel, the Department has implemented the Joint Interagency Combined Space Operations Center to facilitate joint experimentation to ensure we can effectively access, fuse, and analyze all sources of information to enable effective decision making in peacetime and in crisis. This effort will refine optimum command and control relationships, concepts of operations, and materiel solution requirements to achieve operational agility. Achieving this vision will take time to mature these concepts and supporting technology.

This transition will also require a balanced resourcing strategy to ensure the Department can continue to meet current requirements while implementing the force structure of the future. The Department is assessing options to improve resiliency in the next generation of our current systems (i.e., Space Based Infrared System and Military Satellite Communications) while conducting technology development for next generation capabilities. To guide efforts to improve resilience of the national security space enterprise, Air Force Space Command recently released its "Space Enterprise Vision". This vision establishes a new "resiliency capacity" concept that takes into account how well a capability can address a current threat and how quickly they can adapt to counter future threats. This resiliency capacity metric will replace the traditional "functional availability" metric that has been used to characterize and evaluate space capabilities. Implementing the Air Force's Future Operating Concept will also require continued investment in technology development and advances to address future threats. An example of this technology development is the Defense Advanced Research Projects Agency's continuing effort to develop a significantly less expensive approach for routinely and rapidly launching small satellites into low Earth orbit.

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What's being done to make these vignettes reality?

General BUCK. The synergistic Army, Navy, Marine, and Air Force space team at the Joint Functional Component Command for Space and its Joint Space Operations Center (JSpOC) forms the basis for future warfighting enhancements along the lines of a Multi-Domain Operations Center (MDOC). By definition, a true MDOC must not only integrate the Air, Space and Cyber domains within the Air Force but integrate the Land and Maritime domains as well.

A current and ongoing endeavor to better integrate the Joint and Interagency space enterprise is the Joint Interagency Combined Space Operations Center (JICSpOC) experimentation to determine the necessary constructs and processes for unity of effort across the USG. In addition to Joint and Interagency lines of effort, the US Air Force is implementing the Space Mission Force (SMF) and developing a threat-informed Space Enterprise Vision that will increase the resilience capacity of the space enterprise and prepare our space mission forces to effectively respond to space threats. In addition, the SMF and Space Enterprise Vision (SEV) are the foundational elements for developing and implementing the AF strategic vision described in the "Future Operating Concept," to including building a more resilient space enterprise and providing advanced tools and training to increase space crew readiness in order to fully integrate space operations into agile, multi-domain operations.

Mr. LAMBORN. How can we help you achieve your vision?

General BUCK. Predictable funding for capability improvements and increased resilience helps enable the Joint space enterprise focus on refining and developing new tactics, techniques, and procedures. Experimentation efforts, like the current JICSpOC activities, are extremely important in identifying not only how to better operate with current capabilities but also to identify any material gaps requiring acquisition and funding. Current gap assessments identify the need for a fully-funded Space Battle Management Command and Control (BMC2) system. We also face a shortfall in Indications and Warning for the space domain in addition to a shortage of space trained and focused intelligence personnel.

As Commander, JFCC SPACE, I am relying on two significant efforts from Air Force Space Command. First, the SMF focuses operations personnel on providing space effects in contested, degraded and operationally limited (CDO) environments. Second, the Enterprise Ground Services (EGS) initiative provides the common environment from which we can access space and ground asset data gathered at the tactical level of space and provide insight to the operational level of space to determine if we are in a CDO environment and implement actions to mitigate effects. The SMF and EGS will work together to give us insight into the space environment which we simply don't have today. Finally, we're creating a culture of experimentation and change in satellite operations and space warfare to get ahead of the adversaries. We're doing this on the operations side through the Joint Space Operations Center (JSpOC) and support to the JICSpOC experimentation.

Mr. LAMBORN. Also, given that this represents where the Air Force would like to be in 2035, do we really have to wait 20 years to see these concepts become a reality?

General BUCK. If we are to maintain our competitive and operational advantages in, through and from space, it is imperative that we respond and field systems on faster and more agile timelines.

Mr. LAMBORN. What's stopping us from doing it faster?"

General BUCK. Rapidly evolving threats and technologies coupled with a dynamic environment are outpacing our deliberate acquisition processes. We need the ability to observe, orient, decide, and act faster than our adversary through resilient and responsive future space capabilities and tactics. Leveraging near-term experiments in space along with enterprise ground systems will ensure rapid development and maturation of much needed requirements. Establishing resilient Enterprise Ground

Systems and developing and fielding robust BMC2 capabilities to fight on operationally-relevant timelines are critical. In this endeavor, we should explore rapid prototyping, automation, machine-to-machine interfaces and artificial intelligence.

Mr. LAMBORN. Last Fall, the Air Force released its "Future Operating Concept", a strategic vision for where the Air Force wants to go in the next 20 years. It contains several thought-provoking vignettes. One vignette, titled "Space Control Challenged" envisions a Multi-Domain Operations Center which combines and integrates air, space, and cyberspace information and operations. At the MDOC, an Air Force Captain receives warning of an imminent ground-based laser attack on one of our commercial imagery satellites, and then uses big data fusion, analytics and simulation to select an offense cyber response. As the battle continues, he is able to have real-time situational awareness and command and control to fight the war in space. In another vignette, called "Satellites On-Demand", an F–35 pilot responds to an adversary's offensive degradation of U.S. space capabilities by launching an on-demand rapid reconstitution satellite cluster. Once the F–35 releases the satellite cluster at high altitude, a modular satellite booster propels the cluster into orbit, where it deploys into a dispersed network formation of micro-sat's complete with electromagnetic-spectrum measures, which complicates adversary space-control actions. The cluster is thus able to focus its sensors on an area of interest and supports a strike package inbound to attack targets in enemy territory. My question is, what's being done to make this vision a reality across the national security enterprise? How can we work with you to help you achieve your vision? Also, given that this represents where the Air Force would like to be in 2035, do we really have to wait 20 years to see these concepts become a reality? What's stopping us from doing it faster?

Mr. CARDILLO. [The information referred to is classified and retained in the committee files.]

Mr. LAMBORN. Last Fall, the Air Force released its "Future Operating Concept", a strategic vision for where the Air Force wants to go in the next 20 years. It contains several thought-provoking vignettes. One vignette, titled "Space Control Challenged" envisions a Multi-Domain Operations Center which combines and integrates air, space, and cyberspace information and operations. At the MDOC, an Air Force Captain receives warning of an imminent ground-based laser attack on one of our commercial imagery satellites, and then uses big data fusion, analytics and simulation to select an offense cyber response. As the battle continues, he is able to have real-time situational awareness and command and control to fight the war in space. In another vignette, called "Satellites On-Demand", an F–35 pilot responds to an adversary's offensive degradation of U.S. space capabilities by launching an on-demand rapid reconstitution satellite cluster. Once the F–35 releases the satellite cluster at high altitude, a modular satellite booster propels the cluster into orbit, where it deploys into a dispersed network formation of micro-sat's complete with electromagnetic-spectrum measures, which complicates adversary space-control actions. The cluster is thus able to focus its sensors on an area of interest and supports a strike package inbound to attack targets in enemy territory. My question is, what's being done to make this vision a reality across the national security enterprise? How can we work with you to help you achieve your vision? Also, given that this represents where the Air Force would like to be in 2035, do we really have to wait 20 years to see these concepts become a reality? What's stopping us from doing it faster?

Mr. CALVELLI. The NRO's Advanced Systems & Technology (AS&T) Directorate's research and development in the area of time-dominant intelligence collection using the SENTIENT automated mission management schema has promoted new opportunities for future ground architectures. SENTIENT modernizes intelligence collection by introducing modular big-data analytic services in a highly automated, multi-INT system, employing a ground architecture controlling various sensors (strategic, tactical, commercial and specialized systems). In addition to transitioning SENTIENT capabilities into ground architectures, the NRO maintains a SENTIENT research infrastructure and research methodology enabling proof-of-concept demonstrations for prototype capabilities and works closely with the joint community to transition additional capabilities into operational baselines. The Congress, and this committee specifically, have repeatedly provided the NRO the authorization, encouragement, and resources it needs to meet the demands of a contested space environment. Your continued support of this efforts and your partnership in the future is appreciated. The NRO researches and develops new technologies and capabilities to operationalize on a variety of timescales. The NRO is committed to inserting new capabilities and products into the joint architecture routinely in order to assist maturation towards the objective 2035 architecture. Ultimately, the objective architecture may take 20 years before it is a reality, but piece-parts will be delivered along

the way as technologies and systems mature. I'm not aware of any limitations at NRO that are inhibiting the Air Force's "Future Operating Concept." The NRO, working through the Department of Defense and the Intelligence Community, are committed to providing U.S. policymakers and warfighters the collection capabilities and tools necessary to meet national security demands today, tomorrow, and beyond.

QUESTIONS SUBMITTED BY MR. COFFMAN

Mr. COFFMAN. Is there a synergy that could be had between NASA and the Air Force on the development of a new-technology upper stage engine at significantly lower life cycle cost? Could improvements to the upper stage engine support the goal of assured access to space? How does your 4-step acquisition strategy include these opportunities that could benefit not only the AF and NASA, but also the American taxpayer?

General HYTEN. Yes, there is considerable potential synergy with NASA in the development of booster upper stage propulsion. NASA's Low Earth Orbit (LEO) missions, such as LEO science missions, International Space Station (ISS) resupply and commercial crew, fall within the Air Force's mission requirements. NASA's Commercial Crew organization has expressed some interest in how the Air Force executes mission assurance. Additionally, NASA's large Space Launch System (SLS) will utilize an upper stage based on the United Launch Alliance (ULA)'s RL10 engine. The SLS configuration will use a two-engine RL10, while ULA is developing the SLS Exploration upper stage with up to four RL10s. The Air Force's deep experience with RL10 can potentially help NASA's SLS development. However, directing a specific engine is not compatible with the principle of full and open competition and is not part of the Air Force's strategy. If authorized in FY17, the Air Force plans to transition away from using the RD–180 engine by competitively awarding Launch Service Investment (LSI) Other Transaction Agreements (OTAs) to partner with industry on their commercial launch system development efforts while ensuring that their launch systems also meet National Security System (NSS) requirements.

Mr. COFFMAN. Is there a synergy that could be had between NASA and the Air Force on the development of a new-technology upper stage engine at significantly lower life cycle cost? Could improvements to the upper stage engine support the goal of assured access to space? How does your 4-step acquisition strategy include these opportunities that could benefit not only the AF and NASA, but also the American taxpayer?

Mr. LOVERRO. I believe that the Air Force is most suited to address this question for the record. I defer to the Air Force to provide additional information.

Mr. COFFMAN. Once awarded, will the Department's propulsion system provider or providers be the only options for decades to come. How do you plan to continually asset and pursue new and innovative launch technologies?

Mr. LOVERRO. I believe that the Air Force is most suited to address this question for the record. I defer to the Air Force to provide additional information.

Mr. COFFMAN. How would you adjust your 4-step approach to permit the full benefit of competition for the entire rocket stack? Can you ensure that truly new and innovative propulsion providers—some with dramatically new technologies—are made part of your acquisition approach for launch services? What are the on-ramps that you will make available?

Mr. LOVERRO. I believe that the Air Force is most suited to address this question for the record. I defer to the Air Force to provide additional information.

Mr. COFFMAN. How is the Department going to ensure, in its desire to procure a launch service, that the taxpayer receives the full benefit of open competition across the rocket stack, to include the upper stage?

Mr. LOVERRO. I believe that the Air Force is most suited to address this question for the record. I defer to the Air Force to provide additional information.

Mr. COFFMAN. How does the Department's 4-step approach address finding and promoting innovative rocket engine providers, some of whom the government has already invested in via the SBIR program?

Mr. WEATHERINGTON. The first step in the Department's multi-step process to field new and improved launch service capabilities was to issue a Broad Area Announcement (BAA). The BAAs solicited ideas and project proposals that would provide risk reduction and technical maturation in support of future domestic liquid rocket engine and solid rocket motor development activities. The Air Force issued a total of 10 BAA awards to a combination of academic institutions, small and large businesses. The projects include a number of innovated additive manufacturing process development activities for individual rocket engine components, as well as

developing test and qualification standards for those new processes. Opportunities for innovation continue with step 2 investments at Orbital ATK, SpaceX, United Launch Alliance, and Aerojet Rocketdyne through the use of Other Transaction Authority agreements. All these projects will support the broader industry propulsion system development efforts. The final 2 steps of the approach will culminate in the development of new and improved launch service capabilities that will be available to the Department in FY 22.

QUESTIONS SUBMITTED BY MR. TURNER

Mr. TURNER. During the hearing it was stated that the Department of Defense is not pursuing launch systems, but instead pursuing launch services that consist of an integrated solution that addresses the components of main and upper stage engines. How does this approach ensure that new entrants are not shut out because the launch service provider has chosen their own solution?

Mr. WEATHERINGTON. The Department's Evolved Expendable Launch Vehicle (EELV) New Entrant process is designed to ensure every company that wishes to become a certified EELV launch service provider (LSP), has an opportunity to do so. The New Entrant Certification Guide (NECG), issued by the Air Force in October 2011, delineates the top level requirements all prospective New Entrants must meet. The NECG is focused on the LSP requirements and not at the component provider level. The Department's expectation is the LSP will offer an integration solution for the government to evaluate to include incorporating innovative solutions from the 2nd/3rd tier technology base. In addition, the Department presumes the LSP will work with its vendor base to incorporate any and all new and innovative components into their final vehicle design. The Department is already funding some of these technology improvements as part of our Rocket Propulsion System (RPS) program. For example the funded RPS development activities include; the Aerojet AR–1 and Blue Origin BE–4 engines, improved solid rocket motors and launch vehicle upper stage design.

QUESTIONS SUBMITTED BY MR. PETERS

Mr. PETERS. Last year's NDAA had a provision that requires DOD to undertake a Satellite Communications (SATCOM) Pilot program to test out the best commercial SATCOM services. Section 1612, requires that these Pilots are supposed to be separate and different from the Pathfinder program. They were supposed to be "orders of magnitude" better that tested new technology, like high capacity satellites. The Air Force's plan in the FY 17 Budget seems to ignore this Pilot program and it appears there is no plan for testing high capacity SATCOM technology this year, or next year. Does the Air Force have a plan to implement the ComSat "Pilot program" and test this new high capacity technology? And in order to get this new technology to the warfighter, will you expedite the testing of high throughput/high capacity technology?

General HYTEN. The Air Force plans to implement five pathfinders as part of its pilot program. Currently, we are studying life cycle cost affordability implications and potential impacts to Joint Service terminals. Pathfinder #3, which is planned for FY17, will reduce risk by investigating interoperability issues between DOD infrastructure and High-Capacity Satellite ground stations. Pathfinder #5 will incorporate results from the Pathfinder #3 and #4 efforts to further demonstrate interoperability with High Capacity Satellites.

Mr. PETERS. We understand the Department's Purpose-Built and leased Satellite solutions don't take advantage of newer, less expensive technology, like high capacity Satellites: this new technology could enable capabilities, like in-flight tele-medicine for aeromedical evacuation, and ultra-high definition sensors for tactical ISR aircraft. Is there a way to accelerate the Commercial Satellite Pilot program efforts so that these demos or tests of high capacity ComSats, can contribute to the upcoming AOA? If so, will they address countermeasures to jamming and cyber threats?

General HYTEN. As discussed in the answer to the previous question (#65), the Air Force's Pathfinder program is investigating the use of COMSATCOM outside traditional leasing methods, including Pathfinder #5 with high capacity satellites. As we work through these non-traditional acquisitions, we are investigating policy, regulatory, and life-cycle cost implications. The Air Force and the Department expect to incorporate lessons learned from the completed and ongoing Pathfinder efforts in the upcoming Wideband SATCOM AOA. Additionally, the Air Force is addressing jamming threats through other demonstrations like the protected tactical waveform that can be used over COMSATCOM.

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Mr. WEATHERINGTON. The Department's commercial satellite communication (SATCOM) pilot program includes five Defense Information Systems Agency (DISA) and five Air Force pathfinder activities. The Air Force pathfinder program is investigating the use of commercial SATCOM outside of traditional leasing methods, including pathfinder #5 with high capacity satellites. The Department expects to incorporate lessons learned from the completed and ongoing pathfinder efforts in the upcoming wideband SATCOM Analysis of Alternatives. Additionally, the Air Force is addressing jamming threats through other demonstrations like the protected tactical waveform that can be incorporated into commercial SATCOM architectures.

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